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PLANT DISEASE AND PEST CONTROL

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ALFALFA

Crown Wart, *Urophlyctis alfalfae* (Lag.) Magn.—Crown wart was formerly called crown gall, but is not connected with true crown gall (see general subjects, p. 55). Rounded irregular tumors develop near the surface of the ground and some plants may subsequently die. Widely distributed, but not often destructive in California.

Dodder or Love Vine, *Cuscuta* sp.—Yellowish threads grow up and entwine the plants, causing serious injury. This is a parasitic plant with minute flowers and with seeds similar in size to alfalfa seeds. Avoid seed in which dodder occurs. The State Department of Agriculture, Sacramento, maintains a laboratory for testing seeds, to which samples may be sent. Small patches may be killed by mowing and, when dry, burning with additional material or kerosene. Afterwards resow the spot. Badly infested fields should be plowed up. In the drier sections it is reported that dodder may be killed by keeping the field dry for a time, as alfalfa will endure more drought than dodder.

Downy Mildew, *Peronospora trifoliorum* De Bary.—Upper leaves become partly yellow with the edges turned down. The lower sides of the leaves have a fuzz which turns violet. Very common in winter and spring. Not destructive.

Leaf Spot, *Pseudopeziza medicaginis* (Lib.) Sacc.—Small dark spots appear on the leaves, which fade and drop early if spots are numerous. The commonest and most universal trouble of alfalfa in California. Favored by moist atmosphere, and worst on weak plants in dry soils under unfavorable growing conditions. Frequently causes loss of nearly all the leaves. Normally disappears after cutting and good irrigation.

Rust, *Uromyces striatus* Schr.—Powdery dark brown dots appear on the leaves.

Stem Rot or Wilt, *Sclerotinia libertiana* Fel.—Stem rot is caused by the same fungus as cottony rot of lemons, green rot of apricots, fig die back, etc. Vetch and various leguminous cover crops are attacked. Moist weather favors it. Stems rot off near the surface of the ground and the affected part becomes covered with a cottony snow-white mold. Irregular black bodies as large as popcorn grains form in protected places about and in the diseased stems.

Treatment of foliage diseases of alfalfa in California has generally been confined to mowing the diseased stand and applying water if that is needed. Sometimes the ground is disked or treated with a renovator. Early mowing may dispose of a diseased and weedy crop which may be used for silage, or if too bad for this purpose, such a crop makes good orchard mulch. Where the stand becomes too thin or uneven, it should be plowed up and resown. Perhaps no crop is more dependent on proper soil preparation and treatment. Consult your local farm advisor, or write to the University of California, College of Agriculture.

Alfalfa Caterpillar, *Eurymus eurytheme* (Boisd.).—The caterpillars are about one inch long and dark green in color with a distinct and often a pale white or yellow line on each side. They feed on the leaves and may entirely defoliate the plants. The yellow butterflies may be seen in great numbers hovering over the fields. Cutting as soon as the caterpillars appear in destructive numbers, followed by irrigation, is the best method of control.

Armyworms, Cutworms, Grasshoppers, etc.—See “General Subjects,” p. 53.

Clover Seed Chalcis (*Bruchophagus fovealis* How.).—The small white larva of this insect is just large enough to fill the seed. It occurs in sufficient numbers to greatly reduce the seed crop in most localities in the state. Destroying all the seed heads during winter and the straw after threshing will greatly reduce the infestation for the next year.

ALMOND

Armillaria, Crown Gall, Sour Sap.—See “General Subjects.”

Rust, *Transchelia punctata* (Pers.) Arth.=*Puccinia pruni*.—Powdery dark brown dots appear on the leaves in summer and autumn. Also on prune, plum, peach, and apricot. No control is known.

Shot-hole, *Coryneum beijerinckii* Oud.—Principally due to peach blight fungus. Small spots are killed on the young rapidly expanding leaves, the living part draws away from the dead area and the latter drops out. Young fruits are also attacked and may drop. There may be much injury and loss both of fruit and foliage. Spray with lime-sulfur 1-10 just as the buds are swelling.

Unfruitfulness.—Usually due to frost or to rain at blooming time, or to lack of a suitable mixture of varieties for cross pollination (most varieties are self-sterile), or to the lack of bees for carrying pollen, or to weakness from red spider or other injury the previous year. The selection of suitable soils and thermal belt situations offer some difficult problems for the almond. See “Frost” under “General Subjects,” p. 55.

California Peach Borer.—See “Peach.”

Peach Twig Borer.—See “Peach.”

Red Humped Caterpillar.—See “Prune.”

Red Spider or Almond Mite, *Bryobia praetiosa* Koch.—The largest orchard mite, nearly the size of a pinhead; brownish or greenish with reddish legs, the front pair as long as the body and much longer than the other legs. The bright red, globular eggs are laid in great numbers on the limbs and twigs of the trees, where they remain through the winter and hatch in the spring. Spray the trees in the winter (January and February) with lime-sulfur 1-10 or crude oil emulsion (Formula 18) to destroy the eggs. To control the mite during the growing period of the trees apply dry sulfur, sulfur paste, wettable sulfur sprays (Formula 13 or 14), or lime-sulfur 1-50 plus 5 pounds of wettable sulfur as soon as the mites appear in the spring and as often as necessary during the summer and fall. (See Bull. No. 347.)

San Jose Scale.—See “Apple.”

COMBINED SPRAYING

Lime-sulfur spraying when the buds are swelling will control shot-hole fungus and peach twig borer, and help to destroy San Jose scale and the eggs of the almond mite. Crude oil emulsions will also destroy scale insects, almond mite eggs, and will arrest some of the fungus diseases when applied as a dormant spray.

APPLE

Blight, *Bacillus amylovorus* (Burr.) De T.—See “Pear.” Remove all worthless apple, pear, and quince trees near apple or pear orchards. Christmas berry, Cotoneaster, loquat, and related wild or ornamental plants should be watched for blight. See “Pear.”

Mildew, *Sphaerotheca leucotricha* (E. & E.) Salm. & *S. oxyacanthae* (De C.) De B.—A white powdery growth covers leaves and shoots, causing stoppage of growth and distortion. Where abundant the tree is weakened. Especially serious in foggy sections. Cut out mildewed twigs as thoroughly as possible in winter. Use lime-sulfur for scab spraying (See “scab”) or, if scab is not serious, use sulfur paste, 16 pounds to 200 gallons of water (or home-made wettable sulfur spray, Formula 13 or 14) when petals are falling. Later spraying for mildew may be done with the same material. Sulfur sprays cause injury to apple trees in some sections.

Sappy Bark, *Polystictus versicolor* (L.) Fr.—Bark puffs up in winter about wounds and dries out later, becoming loose and papery. Recurs in succeeding winters, causing death of limbs and general breakdown of trees. Caused by wood decay in the interior of the tree. Avoid large wounds or protect them with a covering of asphalt. See “Wood Decay” under “General Subjects.”

Scab, *Venturia inequalis* (Cke.) Wint. = *Fusicladium*.—Velvety dark moldy patches on young fruit and sometimes on leaves and twigs, rough corky spots on mature fruit, with distortion. Spray with Bordeaux mixture (Formula 9) or lime-sulfur 1-20, just as winter buds open. Again with lime-sulfur 1-35 when petals are falling. Bordeaux applied after the bloom may russet the fruit.

Codling Moth, *Cydia pomonella* (Linn.).—The common white or pinkish worm or caterpillar nearly one inch long is found inside the fruit. For control, spray from two to five times as needed. First spray should be applied as the petals are falling, using 2½ pounds powdered or 5 pounds paste arsenate of lead to 100 gallons of water;

the second spraying should be made three weeks later using the same strength. The remaining applications should follow as needed, but should be somewhat weaker, 2 pounds of powdered or 4 pounds of paste arsenate of lead to 100 gallons of water. Cover with a fine, fog-like spray. For a spreader use 1 pound of dry casenite or billboard paste to 100 gallons of spray material. Also see "spreaders" under "General Subjects."

Flat-headed Apple Tree Borer, *Chrysobothris mali* Horn.—The full-grown larvae or borers are white or pale yellow and vary from one-half to three-quarters of an inch in length. The portion just behind the head is greatly enlarged and flattened, a character which is responsible for the common name. The adult beetles lay eggs on sunburned or other dead areas of the trunk. Whitewash trunks to prevent sunburn and repel egg-laying. Avoid injuries and wounds. Dig out borers and paint with asphaltum.

Fruit Tree Leaf Roller, *Archips argyrospila* Walker.—The eggs are laid in small, flat, grayish or brownish masses, usually on the new growth near the tops of the trees, in the fall. They hatch in the spring and the caterpillars draw the leaves together into compact rolls in which they live, and from which they wriggle violently if disturbed. When mature the larvae are nearly three-quarters of an inch long, deep green, with the head and thoracic shield dark brown or black. The most satisfactory means of control is directed against the eggs, and consists in the use of a miscible oil or crude oil spray (Formula 18) during the winter. Great care must be taken to thoroughly drench the limbs and particularly the tops and outside branches. Some relief may be had during the summer by spraying with 2 pounds of powdered or 4 pounds of paste basic arsenate of lead to 100 gallons of water.

Green and Rosy Apple Aphis, *Aphis pomi* DeGeer and *Anuraphis roseus* Baker.—Both of these aphids are easily distinguished by their color and the characteristic curling of the leaves caused by their method of attack. Control measures are difficult and must be thorough to secure satisfactory results. Late dormant lime-sulfur, 1-10, applied just before the buds open, gives fair results in killing the eggs, but it is better to spray from the time of the bursting of the buds until the leaf buds are one-half inch long with nicotine and soap (Formula 27), or with nicotine and distillate emulsion or miscible oil (Formula 24), or to dust thoroughly with 5 or 6 per cent nicodust. At this time the young stem-mothers may be destroyed as they hatch from the eggs.

Red Humped Caterpillar.—See “Prune.”

San Jose Scale, *Aspidiotus perniciosus* Comst.; **Oyster Shell Scale**, *Lepidosaphes ulmi* (Linn.); and **Other Scale Insects.**—The scales of the first are circular and gray, while those of the second are oyster-shaped and similar in color. They occur on all parts of the tree, the first causing a red or purplish stain on the bark and fruit. For the San Jose scale alone, spray with lime-sulfur, 1-10, during the winter months. For a mixed infection of scales, spray preferably with crude oil emulsion (Formula 18), or with distillate emulsion (Formulas 21-23), or with miscible oil. The lighter oil sprays are not so efficient as the crude oil emulsion.

Tent Caterpillars and Cankerworms.—See “General Subjects.”

Tussock Moths, *Hemerocampa vetusta* (Boisd.) and *Notolophus antiqua* (Linn.).—The caterpillars are brilliantly colored and clothed with tufts of white hair on the dorsum, with a single long black tuft at the rear and two in front, the latter being responsible for the name “horn worms.” The eggs appear as white flat felty masses on the old cocoons and on the limbs of the trees. They are deposited in late summer and fall, but do not hatch until the following spring. The female moths are wingless, while the males are normally winged. Control by removing the egg masses during the winter months. Great numbers of the caterpillars may be jarred from the trees and their reascending prevented by applying a band of cotton, wire screen, or tanglefoot around the trunks. Poison sprays are of little use.

Woolly Apple Aphis, *Eriosoma lanigera* (Hausm.).—Easily distinguished by the reddish bodies completely covered with white woolly wax. During the winter months spray with distillate emulsion (Formula 23), miscible oil, or carbolic acid and distillate emulsion (Formula 26a). For the root form, expose the crown of the roots and pour in 4 or 5 gallons of any of the above spray mixtures and recover the roots. Nicotine sulfate (Formula 27) is also effective, or refuse tobacco stems or leaves may be buried in the soil over the main roots during the rainy season. Use para-dichlorobenzene during the fall. Delicious and Northern Spy rootstocks are somewhat immune and are often used to repel serious attacks of this pest. Of the two stocks the former is more vigorous and easily grafted.

COMBINED SPRAYING

1. For serious infestations of scale insects, for removal of moss or lichens, and for a general clean-up, use lime-sulfur 1-10 or crude oil emulsion (Formula 18) during the winter.

2. For green, rosy, and woolly aphid, use distillate emulsion (Formula 23) or miscible oils just as the buds are beginning to open. If only the first two are present and scab is a serious pest, substitute late dormant lime-sulfur 1-10. This will assist in the control of the San Jose scale, if present. Combinations of oil sprays for insects with lime-sulfur or Bordeaux mixture for fungous diseases are not considered advisable.

3. For codling moth and scab use 2 pounds powdered or 4 pounds paste basic arsenate of lead to 100 gallons of 1-35 lime-sulfur when petals are falling. For mildew, add 8 pounds of sulfur paste to each 100 gallons of the above and one-half pint of 40 per cent nicotine sulfate for green or rosy aphid. For later infestations of codling moth and scab, repeat above, following recommendations for mildew and aphid if these need attention.

In large apple-growing districts obtain advice of local horticultural authorities for modifications of the above.

4. For summer infestations of aphid and red spiders, a combined nicotine and sulfur dust may be applied to great advantage.

APRICOT

Armillaria, Crown Gall, Sour Sap, Wood Decay.—See “General Subjects,” p. 53.

Bacterial Gummosis, *Bacterium cerasi* Griffin.—Active during moist weather of winter and spring. Attacks buds, twigs, branches, trunks, and succulent young shoots. On the last there is a killing and blackening of tissue, at first superficial but often killing the shoot. Copious turbid or colored gum appears. Affected bark when cut into shows moist gumming rot. Cut out diseased bark and disinfect wounds and tools as for pear blight. (See “Pear”). After the first rains, the orchard should be frequently inspected and all cankers treated promptly to stop their spreading. Summer treatment is of doubtful value in controlling the trouble, but trees should be repaired to prevent wood decay. (See “General Subjects,” p. 58.) Appears to be increasing in severity. No remedy is known for the phases on buds, twigs and succulent growth in early spring. A heavy Bordeaux spray before the rains begin as for peach blight, may help.

Black Heart.—Certain branches die back suddenly in summer with leaves attached and the wood of affected twigs becomes dark-streaked far back into the tree. Peaches, prunes, and almonds are

sometimes affected. Avoid excessive irrigation, severe cutting back, or otherwise promoting too succulent growth. Make conditions as normal as possible; trees usually outgrow the trouble. A publication on this subject is soon to appear.

Brown Rot, or Monilia Brown Rot, Monilia Blossom Blight, Gummy Twig Blight and Monilia Rot of Ripe Fruit, *Sclerotinia cinerea* (Bon.) Schrot. (*Sclerotinia fructigena* or *Monilia fructigena* in earlier works in America).—The brown rot fungus is active only in moist weather, but may then be very destructive. Flowers are susceptible when the white petals show in the buds and remain so until the “jackets” (calyxes and other flower parts) are shed from the fruit. The fungus grows down through the flower or fruit, causing it to rot, usually without falling, and penetrates into the spur or twig for several inches. Inner bark and wood turn brown and copious amber gum appears. Long shoots may be killed by girdling from a spur. Ripening fruit is attacked (usually in injuries) and rots, becoming covered with dusty gray powder. If allowed to dry out the rotted fruit becomes a tough “mummy,” often hanging in the tree over winter. Where fruits are crowded, whole clusters frequently are lost.

The fungus remains alive in mummies and dead twigs and forms spores during wet weather of winter and spring. All stone fruits and almonds are attacked. The Madeline pear is very susceptible.

After the crop is off, or at any time during fall or winter, remove all mummies and dead twigs and plow them under, bury deeply or burn. Where the disease is serious, spray with Bordeaux 8-8-50 in the red bud stage (just before the white petals show). Or if very bad spray several times in quick succession, continuing up to full bloom. For the fruit rot Bordeaux 4-5-50 may be used up to the time when it will remain and be unsightly on the fruit—perhaps two months before ripening. Lime sulfur is efficient in case of brown rot, but has frequently caused “sulphur sickness” in apricot trees, and is not recommended. Sulfur sickness has appeared as yellowing of foliage, stunting of fruit, and failure of trees to bloom normally the following year.

Bud Blight, Shot Hole, Fruit Spot, Peach Blight, *Coryneum beijerinckii* Oud.—Buds are blackened and killed during winter; spots killed in the opening leaves fall out and leave holes, and small red spots with light centers are formed in the young fruit. Spray with Bordeaux or lime-sulfur between November 15 and December 15, and repeat in spring when buds are showing pink. See “Almond” and “Peach.” Destructive in interior valleys and foothills.

Frost Scabs, Fruit Cracking and Red Specking, Failure of Flower Buds to Open on Strong Shoots, Unfruitfulness of Some Varieties.—Due to climate or obscure causes, and often confused with fungus diseases.

Green Rot and Twig Blight, *Sclerotinia libertiana* Fel.—Often associated with brown rot and confused with it. Where the fungus shows on the surface it is snow white instead of gray as in brown rot, and sclerotia may sometimes be found. (See “Stem Rot” of “Alfalfa,” “Lemon Rot,” etc.). Does not affect the ripening fruit. Control is not developed, but sprays for brown rot should be of some value.

RUST, *Transchelia punctata* (Pers.) Arth. = *Puccinia pruni*.—Sometimes causes small hard points in the skin of the fruit, resembling “fruit spot” above. Also rarely there has been severe dropping of young leaves in early summer following very heavy infection. Early infection apparently came from old rusted leaves which hung on the trees over winter. If this trouble should persist, it would probably be desirable to bring down the old leaves during winter by means of a caustic spray or otherwise. See “Almond,” “Peach,” “Plum.”

Scab, *Cladosporium carpophyllum* Thüm.—Sooty patches to one-half inch in diameter and often confluent form on the fruit, causing drying and cracking. Sprays for brown rot will probably control this, but if not effective, additional sprays after full bloom should be tried, using Bordeaux (Formula 9, p. 74).

Branch and Twig Borer, *Polycanon confertus* Lec.—A small elongated brown beetle, one-quarter of an inch long, which bores clean round holes at the bases of buds, fruit spurs, and in the forks of small twigs. Often makes severe pruning necessary. The insect breeds in dead oaks and prunings of fruit and other trees. Clean up and burn dead brush and prunings around orchards.

Brown Apricot Scale, *Lecanium corni* Bouche, and Black Scale, *Saissetia oleae* (Bern.).—Immature scales of both species are brown or grayish, the latter having a distinct “H” on the back. They mature in May and June and are nearly hemispherical; the former is smooth and brown and the latter black. Control is directed against the immature winter forms which occur on the new growth. Spray the trees when dormant, December to February, with crude oil emulsion (Formula 18), distillate emulsions (Formulas 20-23), and miscible oils, all of which give excellent control for both of these scales. Thoroughness of application is necessary. (See Circular No. 224, Calif. Agr. Exp. Sta., Univ. Calif., Dec., 1920.)

California Peach Borer.—See “Peach.”

Cankerworms.—See “General Subjects.”

Fruit Tree Leaf Roller.—See “Apple.”

Peach Twig Borer.—See “Peach.”

Red Humped Caterpillar.—See “Prune.”

Shot Hole Borer, *Xyleborus xylographus* Say and Bark Beetle, *Eccoptogaster rugulosus* (Ratz.).—Very small beetles boring into the sapwood and heartwood of various fruit trees, preferring usually those not in the best of health. White larvae of the latter may be found during the winter months in sapwood, where they may entirely girdle the trees. Keep the trees growing vigorously; prune out and burn all dead wood; destroy all infested branches immediately.

COMBINED SPRAYING

Lime sulfur 1 to 10, applied as the buds are beginning to open, will control peach twig borer, remove moss and give the trees a general clean up, but this may cause sulfur sickness. (See “Brown Rot.”) General clean up may be accomplished by a dormant spray of crude oil emulsion (Formula 18, p. 82) or miscible oil (p. 85), and peach twig borer may be controlled by adding basic arsenate of lead powder, 3 lbs. to 200 gals. of Bordeaux mixture, in spring, to control brown rot or bud blight and fruit spot. See also “Twig Borer” under “Peach.”

ARTICHOKE

Artichoke Plume Moth, *Platyptilia carduidactyla* (Riley).—This moth is brown with narrow wings and one inch long. The caterpillars are less than one inch long, yellowish with black heads. They feed chiefly upon the developing heads of the artichoke, making deep tunnels or eating through the bracts. Their work is often very destructive and considerable loss occurs every spring because of it.

Field sanitation is one of the best means of control. Infested heads should be removed at every picking and burned. Burning or deep plowing should be practiced to dispose of the old plants after cutting in May and June. Thistles and deserted or wild artichoke plants should be promptly destroyed to eliminate breeding places. Dusting with 5 per cent nicodust or with a combination of 5 per cent nicodust to which 1 pound of powdered arsenate of lead is added to every 4 pounds of the nicodust is recommended after each picking, until the attacks are reduced to a minimum.

Artichoke Aphis, *Myzus braggii* Gill.—A green and black aphid often in immense numbers on the heads and the undersides of the leaves. Dust with 5 per cent nicodust or spray with nicotine, sulfate and soap (Formula 27.)

ASPARAGUS

Rust, *Puccinia asparagi* D. C.—Minute yellowish blisters or sori appear on leaves and stems; these rupture and become rust-colored and dusty and later black. Plants become pale and bare and are much weakened for succeeding crops. Keep down all volunteer growth in and about the fields. Burn all old growth after it dies down and cultivate all surfaces well before new growth comes up. After cutting stops, irrigate and cultivate to secure vigorous growth, and in about three weeks dust with sulfur while the dew is on, or spray with resin-Bordeaux (Formula 10a, p. 75) or lime-sulfur containing fish-oil soap for a spreader, or with fish-oil soap followed by dusting with sulfur while still wet. Repeat once or twice, according to the severity of the disease in the vicinity. For young fields, dust repeatedly with sulfur as above to prevent infection, beginning when the tops first fully feather out.

Asparagus Beetle, *Crioceris asparagi* Linn.—The beetles are slender, one-fourth of an inch long, metallic blue-black with red and yellow markings. The larvae are dull brown or olive green with black head and legs. They feed in great numbers upon the seedlings. Control by clean culture, by cutting and burning seedlings, or by spraying them with nicotine soap spray (Formula 24 or 27.) A 6 per cent nicodust also gives quite efficient control.

Garden Centipede, *Scutigera californica* (Woodw.).—These are small, white, centipede-like animals, scarcely more than one-quarter of an inch long. They live in the damp soil in great numbers and often seriously damage the young asparagus tips before they reach the surface of the soil. Clean culture, winter flooding, and crop rotation are the best control suggestions.

AVOCADO

Pythiacystis Canker, *Pythiacystis citrophthora* S. & S.—Limb and trunk cankers, resembling gummosis of lemon, but the gummy exudate hardens into a granular whitish mass. Treat as for citrus gummosis. See ("Citrus Fruits").

Soil or Water Injury.—Certain sickly conditions apparently caused by uneven moisture due to hardpan or other soil defects. Trees apparently are sensitive to waterlogging of soil and have poor recuperative power after such injury.

Branch and Twig Borer.—See “Apricot.” Sap collecting in the burrows produces, on evaporation, white powdery masses over the entrances, completely concealing them.

Fruit Tree Bark Beetle.—See “Apricot.”

Spanish Red Scale, *Chrysomphalus dictyospermi* Morgan.—A pale brown, circular scale, infesting all parts of the tree and serious in greenhouses, but as yet not adapted to orchard conditions. Control by fumigation with hydrocyanic acid gas.

Thrips: Bean Thrips, *Heliothrips fasciatus* Perg., and Greenhouse Thrips, *Heliothrips haemorrhoidalis* Bouché.—See “Prune.” These insects attack the leaves and fruit, causing a shiny, hard discolored surface which has a tendency to check, or crack, and which is covered with numerous fine specks of excrement.

BARLEY—See “Grain”

BEAN

Anthracnose, *Colletotrichum lindemuthianum* (S. & M.) B. & C.—Spots on leaves, stems, and pods, up to two-fifths inch in diameter, dark-colored, usually with a red border and pinkish in the center. Very rare and unimportant in California.

Mildew, *Erysiphe polygoni* D. C.—Forms a powdery white covering over green parts of the plants; later brownish. May seriously reduce the vitality of the plants. Dust with sulfur at first appearance, or with sulfur nicodust if thrips or aphids are present. Sometimes appears late where the pods are well formed. No treatment is necessary in that case.

Rust, *Uromyces appendiculatus* (Pers.) Link.—Rust-colored spore masses or sori of pinhead size break through the lower surface of the leaf, with yellow spots above. Affected leaves are weakened and production decreases. Dust with sulfur at first sign of the disease and keep the surface of the soil dry by cultivation. Resistant varieties have been reported.

Wilt or Stem Rot, *Corticium vagum* B. & C.=*Rhizoctonia*, and *Fusarium* sp.—Many plants die while small from rot near the surface of the soil, while others wilt at different stages. Prepare the soil very thoroughly, plant as late as possible, avoiding cold and wet weather. Save seed from strong, well-matured plants.

Bean Aphis, *Aphis rumicis* Linn.—A small black louse collecting in great numbers on the leaves and tender tips. Use 5 per cent nicodust or spray with nicotine paste spray (Formula 27a).

Bean Thrips, *Heliothrips fasciatus* Perg.—A small dark thrips with black and white wings. The larvae are white and pinkish and appear in great numbers on the lower surface of the leaves. Treatment the same as for bean aphid.

Bean Weevil, *Acanthoscelides obtectus* Say.—The adults are short, robust, and about one-eighth inch long. The color varies from gray to brown with pale spots on the dorsum. The larvae work within the stored beans, from which the adults emerge through round holes. Breeding continues in storage. Fumigate in storage with carbon bisulfid, 10 to 30 pounds to every 1000 cubic feet of air space, the amount depending upon the tightness of the container. The temperature should be above 70° F. to secure satisfactory control by killing eggs, larvae, and adults.

Garden Nematode.—See "General Subjects." Black eyes and Teparies are more resistant than other beans, but are sometimes badly infested.

Red Spider or Two-Spotted Mite, *Tetranychus telarius* Linn.—A very small yellow, pale green or reddish mite, often with two large, or six small, dark spots on the body. Feeds on the under side of leaves and often spins a considerable web. If possible keep the beans well irrigated and cultivated and in good healthy condition. Begin sulfuring as soon as the mites appear and continue throughout the summer, using 90 parts of dry sulfur to 10 parts of finely ground dry hydrated lime.

Wireworms.—See "General Subjects."

BEEET

Curly-leaf =, Curly-top or Blight.—Transmitted by the beet leaf hopper, *Eutettix tenella* Baker. Leaf margins curl inward or rarely outward and are much dwarfed and deformed; plants are stunted and easily killed by drought and heat; young leaves show transparent venation (a clearing of the ultimate leaf vein branches), and a warty condition usually develops on the backs of veins on old leaves. Roots often become hairy and show dark rings in cross-section. In the cool districts subject to ocean fogs, the insects do not reproduce abundantly and the disease when established is less injurious. Beets in all other parts of the Pacific slope and of the Rocky Mountains are liable to injury, but in certain regions have been observed to

suffer less than in others. Early planting to bring the beet to a good size before the spring invasion of the insects from plains and foothills is generally successful except in years following early fall rains, which bring up filaree and other vegetation and cause a large number of insects to winter in the cultivated area. Blighted "stechlings" do not produce seed successfully, although the symptoms may not always be apparent.

The sugar beet leafhopper, *Eutettix tenella* Baker, referred to above is wingless in the immature form and winged when full grown. The adults average about one-fourth inch in length. The color varies with the season; those of the spring brood being pale green; those of the summer brood cream colored; while the winter generations are dark colored with darker markings on the wing covers. The insects are to be found chiefly on the under surfaces of the leaves or between the stems near the crown, thus producing the characteristic "curly-leaf" described above.

Downy Mildew, *Peronospora schachtii* Fel.—Inner leaves become curled, dwarfed, and covered below with a violet mildew. Develops in moist weather. Remove affected plants and destroy.

Leaf Spot, *Cercospora beticola* Sacc.—Leaves have dead gray spots, mostly one-sixteenth inch in diameter or smaller with borders of brown or purple. Treatment not considered necessary.

Rust, *Uromyces betae* (Pers.) Kuhn.—Powdery dark brown pustules of pinhead size appear on the green leaves. Not serious.

Seedling Root Rot, *Corticium vagum* B. & C.=*Rhizoctonia*, and *Fusarium* sp.—Roots are injured and become misshapen and forked; plants are delayed or stunted or die. Make the soil conditions as favorable as possible for vigorous growth. Replant if the stand is too thin.

Armyworms and Cutworms.—See "General Subjects."

Beet or Spinach Leaf-miner.—See "Spinach."

Grasshoppers.—See "General Subjects."

Nematodes.—See "General Subjects." The beet is attacked by two species, the garden nematode, *Heterodera radiculicola* Greef, which produces galls on a number of plants, and the beet nematode, *H. schachtii* Schmidt, which is confined to sugar beets and does not produce galls.

Wireworms.—See "General Subjects." For the sugar beet wireworm, *Limonius californicus* (Mann.), plow in fall to destroy the pupae. Plant early and practice clean culture. Trap the adults by means of piles of straw and burn in late fall or winter.

BUSH FRUITS (Blackberry, Loganberry, Raspberry)

Bluestem, *Verticillium caulophagus* (Law.)—Blackcaps and variety Ranare are said to be particularly susceptible. Plants become sickly and canes die back; longitudinal dark streaks appear in the wood when the stems are cut across. Control not developed. Select plants from healthy fields.

Cane Blight, *Leptosphaeria coniothyrium* Sacc., = *Coniothyrium*.—Dead areas appear on the canes, which are often girdled and killed. Cut out and burn all affected parts in the fall. Spray with Bordeaux during the dormant season. Sometimes confused with *anthracnose*, which we have not recognized in California.

If foliage and cane diseases are serious, there will probably be an advantage in removing the fruiting canes immediately after the crop is off, or at least before any moist autumn weather. Spray during the dormant season with lime sulfur 1-10 or Bordeaux (Formula 9, p. 74). Give proper irrigation and cultivation. If fields become unhealthy, reset in new land, using healthy plants.

Crown Gall, *Bacterium tumefaciens* Sm. & T.—See "General Subjects."

Fruit Mold, *Botrytis* and Other Fungi.—Avoid mixing bruised or moldy berries with good ones.

Leaf Spot, *Septoria rubi* West.—Small dead spots on leaves and canes with brown or reddish borders. Liable to be severe on the variety mammoth and on wild dewberry. Treat as for cane blight above.

Orange Rust, *Gymnoconia interstitialis* (Schlect.) Lagerh.—Individual plants are affected and ruined. New shoots come up pale, dwarfed and with the leaves curved inward and drawn upward. The surface of the leaves becomes covered with orange colored spores. Dig out and burn affected plants at the first appearance of the disease. Spray healthy plants in the vicinity with Bordeaux mixture to prevent infection.

Raspberry Horntail, *Hartigia cressoni* (Kirby).—The small white larvae are shaped somewhat like the letter "S" and when mature are nearly one inch long. They first attack the tender tips of the new canes and after girdling them and causing wilting they work down the pith to the roots, where they spend the winter. Cut off the young tips as soon as wilting is noticed so as to kill the larvae before they reach the roots. Remove all dead canes in winter, using care to dig out the borers at that time.

Rose Scale, *Aulacaspis rosae* (Bouché).—A pure white scale often found in great numbers at the bases of the old canes. Spray in winter with distillate emulsion (Formula 23) or with miscible oil. Prune out old canes every year, because infestation spreads from them. Serious only where pruning is not practiced every year. Lime-sulfur used as a fungicide gives some control.

The Blackberry Mite, *Eriophyes gracilis* (Nalepa).—This is a small microscopic mite causing the red-berry condition of the Himalayá blackberry throughout the state. The mites attack the drupelets of the berries shortly after the flowers open and continue to work in the fruit, preventing ripening. The winter is spent in the buds and the pest can be effectually controlled by spraying the infested vines in the early spring, in February or March, as the leaf buds are opening, with lime-sulfur solution, 4 gallons to 100 gallons of water.

Summer control may be obtained by spraying with 5 pounds of wettable sulfur to 100 gallons of water.

CABBAGE

Yellows, Wilt, *Fusarium conglutinans* Woll.—Plants gradually turn yellow with falling of lower leaves. Stem shows dark ring when cut across. Loss may be severe. Reported as especially troublesome on kale. Grow plants in soil free from disease. (See “soil disinfection,” p. 95.) Avoid infected land. Certain strains of cabbage are resistant.

Armyworm and Cutworms.—See “General Subjects.” Scatter poison bran (Formula 4) broadcast over the ground and plants in the evening.

Cabbage Aphis, *Aphis brassicae* Linn.—A small green aphis entirely covered with fine whitish powdery wax. Is best controlled by liberal and repeated applications of nicotine-distillate spray (Formula 24) or of nicotine soap (Formula 27). Nicodust gives only partial control.

Cabbage Worm, *Pontia rapae* (Linn.).—A small green, velvety worm, one inch long when mature, which feeds upon the leaves and destroys the heads. The adults are white butterflies with dark spots on the front wings. Young cabbage plants may be protected by using arsenate of lead, 1 pound of powder or 2 pounds of paste, to 50 gallons of water. This should not be applied after the heads are formed because of possible poisoning of humans. Later control may be accomplished by applying a nicotine soap spray (Formula 27). A 5 per cent nicodust also gives very good control when liberally applied.

Cabbage Root Maggot, *Phorbia brassicae* Bouché.—The small white maggots, one-fourth inch long, are found tunneling the roots which are often completely destroyed by them. The insect also attacks radishes, turnips, cauliflower and other related plants. The most effective means of control is in the use of a repellent composed of 1 ounce of corrosive sublimate to 10 gallons of water. Three applications should be made, using one cupful ($\frac{1}{4}$ pint) around the base of each plant, as follows: 1st application 3 or 4 days after transplanting; 2nd application 9 or 10 days after transplanting; 3rd application 19 to 20 days after transplanting. Later applications should not be made on account of the danger of poisoning the plants for market. The material may be applied with a watering can by regulating the flow. Clean up all refuse in the fall and plow and cultivate thoroughly during fall, winter and spring before transplanting to expose and kill overwintering pupae in the soil.

CAMELLIA

Bud Blight.—Browning of the tips of the buds, followed by their decay and dropping, due frequently to injury from thrips. This should not be confused, however, with the dropping of the buds caused from lack of irrigation.

CANTALOUPE. See "Melon."

CASABA. See "Melon."

CELERY

Blight, *Cercospora apii* Fr. and *Septoria petroselini* Desm.—Large or small dead spots appear on the leaves and leaf stalks, especially after cutting, and rapid deterioration follows. Spray repeatedly with Bordeaux (Formula 9), especially in moist weather, commencing in the seed bed.

Aphids, *Rhopalosiphum persicae* (Sulz.) and *Siphocoryne capreae* (Fab.).—Green aphids attacking the stems and leaves of the plants. Spray with nicotine soap (Formula 27) or dust with 5 per cent nicodust.

Celery Caterpillar, *Papilio zolicaon* Boisd.—The caterpillars are beautifully marked, green, black and orange, and feed upon the leaves. Hand pick or spray with arsenate of lead not later than three weeks before harvest (Formula 2).

CHERRY

Armillaria, Wood Decay, Sour Sap.—See “General Subjects.”

Gummosis, Die-back.—See “General Subjects.” Several distinct troubles are involved, and frequently diagnosis is difficult. On certain shallow soils it is reported that cherries die after a few years with copious gumming throughout the top. For bacterial gummosis it is recommended to grow Mazzard seedlings in the orchard and top work after several years with the desired varieties above the main forks. (See “Apricot.”) Cherries are sensitive to excess of water in the soil and to summer drought and do not recover well from injury through soil defects.

Leaf and Fruit Spot, *Coryneum beijerinckii* Oud.—See “Apricot,” “Peach,” “Almond.”

Leaf Curl, *Exoascus cerasi* Fuckel.—Leaves are affected in a way similar to peaches with peach leaf curl, but the symptoms less pronounced. (See “peach.”) The treatment for peach leaf curl has been reported by practical orchardists to be successful on cherry. Rather rare.

Leaf Spot, *Coccomyces hiemalis* = *Cylindrosporium*.—Tiny spots covering most of the leaf surface and becoming fused at the lower edge. Under side shows whitish coating of spores. Not serious as yet. Controlled in the East by Bordeaux mixture, 5-5-50, or lime-sulfur 1-50, adding iron sulfate $1\frac{1}{4}$ pounds, or dusting with sulfur. Applications as follows: (1) when the fruit is free from the calyx, (2) two weeks later, (3) just after the fruit is picked.

Black Cherry Aphis, *Myzus cerasi* Fabr.—A shiny black aphid with long honey tubes, appearing in spring and early summer and causing severe curling of the leaves. Spray with nicotine and soap (Formula 27) or dust thoroughly with 5 per cent nicodust as soon as aphids appear.

California Peach Borer.—See “Peach.”

Cankerworms.—See “General Subjects.”

Cherry Fruit Sawfly, *Hoplocampa cookei* (Clarke).—The small white larvae work within the partly developed fruits of the cherry and plum and are at times responsible for much damage. Their presence is indicated by the dropping of fruit and by the small round exit holes in fruits which are hardly half-grown. The best treatment is the application of arsenate of lead (Formula 2) just when the petals are opening.

Cherry Slug, *Caliroa cerasi* (Linn.).—The common name applies to the small dark green or blackish slug-like larvae which are nearly one-half-inch long and which feed upon the leaves in great numbers almost defoliating the trees in some years. Because of their slimy covering they are readily killed by the application of various dusts, such as finely ground hydrated lime, ashes, road dusts, etc., but are best controlled by the applications of 2 per cent or 5 per cent of nicodust. The regular arsenate of lead sprays (Formula 2) are also good.

Pear Thrips.—See "Pear."

Red Humped Caterpillar.—See "Prune."

Tent Caterpillars.—See "General Subjects."

CHRYSANTHEMUM

Rust, *Puccinia chrysanthemi* Roze.—Small dark pustules or sori appear on the lower side of leaves. Fertilize and irrigate freely to produce vigorous plants.

Aphids (Various Species).—Spray with nicotine and soap (Formula 27) or dust with 5 per cent nicodust when the insects appear.

Chrysanthemum Gall Fly, *Diarthronomyia hypogaea* (Löw).—The small yellowish or white larvae cause numerous pointed galls on the leaves and stems and seriously injure the terminal buds. Great numbers of minute slender red eggs are laid on the plants in the spring and early summer, and these may be readily killed by repeated applications of nicotine and soap (Formula 27). Trim the plants to the ground in spring to eliminate hold-over forms.

Chrysanthemum Leaf Miner, *Phytomyza chrysanthemi* Kow.—The injury due to this insect consists in numerous mines on the upper side of the leaves just under the epidermis. These are made by the small whitish maggots, which are easily killed within their burrows by applying one part of 40 per cent nicotine sulfate to 600 parts of water.

CINERARIA

Leaf Miner.—Injury similar to that of the chrysanthemum leaf miner and caused by the same insect.

CITRUS FRUITS (Grapefruit, Lemon, Orange)

Blast, Black Pit, *Bacterium citriputeale* C. O. Smith.—Blast occurs only in very moist seasons and districts; black pit occurs with blast and also, rarely, in less moist localities. Blast is a watery deterioration of leaves and petioles extending to a shield-shaped area in the

twig about the base of the leaf. Leaves die and dry up in place, the twig lesions turn dark, dry up, and heal, and shed off in two or three years. Where several leaves are killed, the twig may be much weakened or die. Black pit consists of dark, sunken spots in the rind of the fruit. They do not decay. Grow bushy, compact trees and avoid severe pruning. Protect the orchard with windbreaks against prevailing rain storms. For northern California conditions, spray from October to December with Bordeaux or ammonia copper carbonate; repeat as soon as the fruit is off or before January 1 with Bordeaux.

Blue Mold, Green Mold, *Penicillium* sps.—Rots the entire fruit, starting in spots and becoming a powdery blue or green, and gray. Avoid even minutest injuries in picking and handling fruit.

Brown Rot of Lemon or *Pythiacystis* Rot, *Pythiacystis citrophthora*, S. & S.—See also "Gummosis." This disease is distinct from brown rot of apricots or monilia rot. A rather light brown rot of fruit, causing only slight change in texture at first; develops rapidly and spreads by contact. There is a characteristic odor and a slight surface mold in moist atmosphere. Develops in moist weather. When prevalent, spray the lower branches and ground beneath with Bordeaux mixture (Formula 9). Straw mulch also is useful. Do not allow boxes of fruit to stand over night in the orchard. Use blue-stone in the wash water (Formula 12, p. 75), maintaining a constant strength of 1½ lbs. to 1000 gals. Consult your farm advisor for special methods for keeping the strength of solution constant where alkaline water is used. Grade out very carefully all orchard infected fruits before storing.

Cottony Rot, *Sclerotinia libertiana* Fcl.—See "Alfalfa," "Apricot," etc. A serious citrus fruit rot in storage locally after wet weather. A snow white downy mold appears, causing a soft rot which spreads rapidly by contact. Twigs are sometimes killed. Treatment as for brown rot of lemon, but the spores are much more resistant. See the farm advisor or consult the University of California, College of Agriculture, for details in control.

Damping Off, *Armillaria* Root Rot, Wood Decay.—See "General Subjects," p. 53.

Gummosis, *Pythiacistis citrophthora* Smith & Smith.—Copious exudation of gum on the lower part of the trunk. The bark of the affected part dies and the diseased area may continue to spread until the tree is girdled and killed. Cut out all affected bark as soon as discovered and treat the wounds with Bordeaux paste (Formula 10,

p. 74). Do not allow water to stand about the base of trees. In planting keep the point of budding well above ground and never allow the soil to pile up around the trunk. For heavy soil, use trees high-budded on sour orange root. See also "General Subjects," p. 56.

June Drop.—Young fruits up to nearly 1 inch in diameter turn pale and drop off. Especially troublesome with navel oranges during severe hot periods. Any deficiency in vigor of the tree or of moisture supply in the soil will presumably make the trouble worse. Build up the vigor of the trees; secure the best possible moisture condition of the soil; plant windbreaks. Consult your farm advisor or local authorities.

Mottled Leaf.—Add as much organic matter to the soil as possible in the form of green manure crops, bean straw, and manure. Avoid continual fertilization with nitrate of soda. See that water penetrates to the subsoil and keeps it uniformly moist. See "General Subjects," p. 57.

Scaly Bark.—Bark at first becomes roughened in a small area; roughening spreads and deepens, finally gumming heavily, encircling the trunk or limb and causing its death. Scrape off all visibly affected bark, leaving the inner bark, extending 2 or 3 inches beyond the edges of the spot. Cover the wounds with Bordeaux paste (Formula 10) or other suitable fungicide. Cut off badly affected branches. Watch all trees very closely in groves where the disease is present and eradicate new cases at first appearance. Do not use Bordeaux if the trees are soon to be fumigated.

Aphids (Various Species).—Use nicotine and soap spray (Formula 27 or a 5 per cent nicodust.

Armyworms and Cutworms.—See "General Subjects."

The European Red Mite, *Paratetranychus pilosus* C. & F. and the Two-Spotted Mite, *Tetranychus bimaculatus* Harvey.—The first is bright cardinal red, while the two-spotted mite is yellow, pale green or reddish and often has two or six dark spots on the dorsum. Dust with sulfur or spray with lime-sulfur 1-50 or wettable sulfur (Formula 14), or commercial sulfur paste 10 pounds to 100 gallons of water.

Citrus Thrips, *Scirtothrips citri* (Moult.).—Small pale yellow insects less than one-thirtieth inch long working in blossoms and on leaves and fruit. This insect is most satisfactorily controlled by a 2 per cent solution of commercial lime-sulfur, but may also be controlled by using the Government formula for pear thrips (Formula 24) or by applications of 6 per cent nicodust. A combination of mis-

cible oil and lime-sulfur is recommended by some for killing the gray citrus scale (*Coccus citricola* Campb.) and the citrus thrips at the same time.

Fuller's Rose Beetle, *Pantomorus fulleri* (Horn.).—A small gray snout beetle three-eighths inch long which attacks young buds and foliage of citrus trees. The adults cannot fly and may be kept off the trees by cotton or tanglefoot bands around the trunks.

Mealybugs (Various Species of *Pseudococcus*).—These small, flat, oval insects, covered with white mealy material, are well known to most citrus growers. They are difficult to control, but may be most satisfactorily handled by liberal applications of carbolic acid emulsions (Formulas 26 and 26a) and by miscible oils. Washing with water under heavy pressure has proved satisfactory under certain conditions. For the citrus mealy bug, parasites are used with splendid results along the coast. The control of ants is necessary to secure beneficial results from natural enemies. See "Ants."

Scale Insects (Many Species).—Fumigation with hydrocyanic acid gas is best, although some orchardists secure good results, particularly for soft brown and gray citrus scales, by repeated and thorough applications of various strengths of distillate emulsions (Formulas 20 and 23) and miscible oils.

CORN

Boil Smut or Common Smut, *Ustilago zeae* (Beckm.) Ung.—Tender tissues of tassel, ear, or stalk swell into large soft masses, which dry out, becoming fragile and filled with black dust. Sometimes gathering up and destroying the smutted stalks before the smut balls dry is recommended. Seed treatment is not effective. Often serious in California. Rotation is perhaps useful. Diseased corn trash and manure are infectious.

Ear Mold, *Diplodia zeae* (Schw.) Lev. and *Fusarium* sp.—The ears mold in the field, the kernels becoming crusted together and light. Sometimes bad in late corn in shallow soil. Use early varieties. Harvest and cure as early as possible. Avoid over-irrigation.

Head Smut, *Sphacelotheca reiliana* (Kuehn.) Clint.—Ear and whole top of plant are affected. No grain formed. See "Sorghum."

Angoumoise Grain Moth.—See "Grain."

Armyworms and Cutworms.—See "General Subjects."

Corn Earworm, *Chloridea obsoleta* (Fab.).—The larvae are nearly two inches long when full grown and vary in color from yellowish to brownish, with longitudinal gray and white stripes and with eight

small dark tubercles on each segment. They work chiefly on the corn in the ear, but may also attack the tassels and leaves. Clean up and burn refuse in the field. Plow in fall or early spring to expose and kill the pupae. Repeated dusting of ears with powdered arsenate of lead one part to four parts of hydrated lime gives some relief.

Granary and Rice Weevils.—See “Grain.”

Grasshoppers.—See “General Subjects.”

Wireworms.—See “General Subjects.”

COTTON

Bean Thrips.—See “Bean.” This insect usually appears on the cotton late in the season, when the injury is not of sufficient importance to justify control. Early infestation should be promptly dealt with.

Corn Earworm.—See “Corn.” Attacks the cotton bolls. Sweet corn is sometimes planted as a catch crop. Dusting with powdered arsenate of lead or calcium arsenate gives good results.

Cotton Leaf Perforator, *Bucculatrix thurberiella* Busck.—The larvae are pale or dark greenish and less than one-half inch long. When disturbed they wriggle violently. The work consists in perforating the leaves with very many holes so as to almost entirely consume them. The larvae pupate in small, white-ribbed cocoons attached to the leaves or stems of the plants. The adults are white with black dots and other black markings.

This insect normally feeds upon wild cotton, but in recent years has invaded the cotton belt of the Southwest, and, while it prefers weak plants, it will attack perfectly healthy ones as well.

Parasites do much to keep the insect in check but where severe infestations occur dust plants with calcium arsenate alone or with lead arsenate, one part to four parts of hydrated lime. From 20 to 30 pounds are sufficient for an acre of cotton.

Red Spider or Two-Spotted Mite, *Tetranychus telarius* Linn.—See “Bean.”

CUCUMBER

Mildew, *Erysiphe cichorearum* D. C. = *Oidium*.—Fine white mycelium covers the leaves. Dust with sulfur at first appearance or with sulfur nicodust if the melon aphid is also present.

Flea Beetles (Various Species).—Small flea-like beetles which jump quickly and eat small holes in the leaves. Bordeaux mixture (Formula 9) as a repellent is the best control measure. This treatment is also recommended for mildew.

Garden Nematode.—See “General Subjects.”

Melon Aphis.—See “Melon.”

Red Spider or Two-Spotted Mite.—See “Bean.”

Western Twelve-Spotted and Striped Cucumber Beetles, *Diabrotica soror* Lec. and *D. trivittata* Mann.—The former is a small green beetle with twelve black spots on the back and is often mistaken for a ladybird; the latter is a brown beetle with three black lines on the dorsum. The white larvae feed upon the roots and may be controlled by pouring on the roots a cup of 40 per cent nicotine sulfate diluted 1 to 1000 parts of water. Bordeaux mixture (Formula 9) is of considerable value as a repellent. Arsenate of lead (Formula 2) may also be used with good effect.

CURRENT, GOOSEBERRY

Mildew, *Sphaerotheca mors-uvae* (Schw.) B. & C.—A fine white mycelium grows over the young leaves and shoots and checks their development. Serious on some varieties. The best treatment is to spray with lime-sulfur 1-33 when buds commence to open and two or three times thereafter at intervals of 10 to 14 days. Where serious cut and burn diseased tips of canes while dormant, as the fungus winters in them (from U. S. D. A. Farmers' Bull. 1024). In California, where resistant varieties are used, a dormant spray of lime-sulfur 1-10, followed by dusting with sulfur when the disease first appears, has generally been effective.

Currant or Gooseberry Fruit Fly, *Epochra canadensis* Loew.—Small white maggots in the fruit at picking time. Cultivate thoroughly during the fall, winter, and spring months to expose and destroy the hibernating pupae.

Flat-Headed Apple Tree Borer.—See “Apple.”

Imported Currant Borer, *Aegeria tipuliformis* Clerck.—White caterpillars nearly one inch long working down the middle of the stalks and into the roots of the plants. Cut out and burn all dead and infested canes during winter and remove the borers.

Red Spider or Two-Spotted Mite, *Tetranychus telarius* Linn.—See “Bean.” Dust with sulfur or spray with wettable sulfur (Formula 14) or sulfur paste (Formula 13.)

San José Scale.—See “Apple.”

COMBINED SPRAYING

The sulfur sprays will control both the mildew and the red spider.

DAHLIA

Mildew, *Erysiphe* sp.—White spots spread over lower leaves. Not serious. Dust with sulfur.

Bean Aphis.—See “Bean.”

Western Twelve-Spotted Cucumber Beetle.—See “Cucumber.”

DATE

Date Palm Scale, *Parlatoria blanchardi* (Targ.).—A small gray and white scale, less than one-sixteenth inch long, often occurring in great numbers on the leaves. It may be controlled by cutting away and destroying all the leaves, burning over the trunk with a gasoline torch. Offshoots are cleaned up by heavy fumigations with hydrocyanic acid gas. This insect is quarantined by the Federal Horticultural Board, and young plants may be obtained only from uninfested territory.

Dried Fruit Beetle.—See “Prune.”

Indian Meal Moth.—See “Prune.” This insect is a serious pest to dried dates, of which small amounts are preferably put up only in insect-proof containers to prevent infestation.

Marlatt Scale, *Phoenicococcus marlatti* Ckll.—A red-bodied, cottony covered scale, considerably larger than the date palm scale. It is chiefly found in the unfolding leaves, often so protected as to be almost impossible of control. Fumigating and burning over the trunks and treating liberally with carbolic acid and oil emulsions give some control, but eradication on a tree once thoroughly infested is apparently impossible. This pest is also under federal quarantine, and new plants may be obtained only from uninfested territory.

Red Spider.—See “Citrus.”

FERNS

Black Scale and Plant Lice.—Dip the plant frequently in a solution of 40 per cent nicotine sulfate, 1 part to 600 parts of water.

FIG

Dropping of Fruit.—Usually due to lack of caprification by the minute fig wasp bringing pollen to the flowers from the wild or Capri fig. Applies only to certain varieties as the Calimyrna. Consult literature on fig culture and authorities on the subject.

Smut, *Aspergillus niger* V. Tiegh. = *Sterigmatocystis ficuum* (Reich.) Henn.—Caused by one of our commonest molds. Infection occurs in ripening fruit; if at an early stage, the fruit rots, if later it is harvested. In extreme cases the dried fruit is merely a shell filled with purplish black dry powder which may be puffed out. There are all gradations to the condition in which the interior of the fig is merely slightly darkened. Affected fruit is said not to give an offensive flavor, nor to be injurious to health. Does not develop in the stored dry figs. Remedies not yet developed.

Souring and Splitting.—Due to unfavorable atmospheric and soil moisture conditions. Choose suitable localities and regulate the soil moisture with greatest care.

At least two canker diseases are known in California, and twig blight is caused to a limited extent by *Sclerotinia libertiana* and *Botrytis cinerea*. Frost is often injurious to young trees which make late growth. (See "General Subjects.") None of these appears to be serious.

Branch and Twig Borer.—See "Apricot."

Mediterranean Fig Scale, *Lepidosaphes ficus* (Sign.).—Scales resemble small oysters and infest the limbs, twigs, leaves, and fruit. Spray with distillate emulsion (Formula 23), miscible oil or crude oil emulsion (Formula 18) during the winter when the trees are dormant.

Nematodes.—Becoming increasingly serious. No remedy known. See "General Subjects."

Pomace or Vinegar Fly, *Drosophila melanogaster* Meigen.—Small, slender, whitish maggots and brown or orange-colored flies one-tenth inch long, often occurring in great numbers in figs on the trees and on the drying trays.

GRAIN (Barley, Oats, Wheat)

Rust, *Puccinia* sps.—Pustules of pinhead size, round or elongated, break through the surface of leaves and stems; mostly reddish at first and dusty; later black. Serious in heavy grain in moist situations or seasons. No remedy known but resistant varieties may be used.

Smut, *Ustilago* sps. and *Tilletia* sps.—Mature grain has black content and gives off characteristic odor. Seed of wheat, barley, oats, Sudan, millet, and sorghum should be carefully cleaned of smut balls, weed seeds, and small, cracked, and inferior grains before treating. The smut balls in wheat and smut masses in barley may be cleaned out

in fanning mills or floated out in water and skimmed off. Place the cleaned seed in half-filled sacks tied at the end. Immerse these sacks for three or four minutes in a bluestone solution made by dissolving 1 pound of bluestone in 5 gallons of water (Formula 11). Drain the sacks until dripping no longer occurs, then dip them for three minutes in a milk of lime made by slaking 1 pound of quicklime in 10 gallons of water. The lime prevents injury to the germ from bluestone. If quick-lime cannot be secured, air-slaked lime, 1 pound to 8 gallons of water may be used. After this treatment the grain should be spread out to dry, after which it may be planted or stored.

Oats are especially sensitive to bluestone, and for them it is better to use a solution of formaldehyde, 1 pound to 40 gallons of water, for ten minutes. After this no lime dip is needed. Barley is more sensitive than wheat and should always be lime-dipped after treatment with bluestone.

Seed scratched or injured in threshing should be limed after dipping in bluestone solutions. Scoured seeds should not be dipped in any fungicidal solution.

Seed wheat and barley to be sown in dry ground or to be stored longer than 48 hours must not be treated with formaldehyde, as severe injury may follow.

If foggy or rainy weather is liable to interfere with the proper drying of lime-treated seed, heating injury may be avoided by soaking the seed for 10 or 15 minutes in water before dipping in the bluestone solution. The lime dip may then be omitted.

Copper carbonate dust has been highly successful in controlling bunt, but is not so successful with other smuts. The copper carbonate dust does not cause seed injury, and appears to stimulate growth. Dusted seed may be stored dry for long periods without injury to seed. A number of serviceable machines for applying the dust are on the market. Finely powdered bluestone also gives good smut control, but is not equal to copper carbonate, for seed injury may occur in badly scratched or broken seed.

Loose smuts of wheat and sorghum cannot be controlled by the above treatment. Loose smuts of oats and barley are destroyed by formaldehyde solution (1 pint to 30 gallons of water), soaking for 10 minutes. Kernel smut of sorghums and Sudan grass is controlled by soaking the seed in formaldehyde solution, as above, for 30 minutes for grain sorghums and 60 to 90 minutes for sweet sorghums and Sudan. Ergot of rye and rye grass is controlled by floating off the ergots in a strong brine solution (40 pounds salt in 25 gallons water) and rinsing with clear water, or by holding the seed for a year before sowing.

Angoumoise Grain Moth, *Sitotroga cerealla* Oliv.—A small tawny moth found in granaries. The pale yellow caterpillars feed within the kernels of stored grain and corn, escaping through a round hole. Control measures are the same as for the granary and rice weevils. See below.

Aphids (Many Species).—Aphids often seriously attack grain. Control methods are usually too costly to be practicable. Cutting is often resorted to in order to save that part of the crop.

Armyworms and Cutworms.—See “General Subjects.”

Grain Mites, *Tyroglyphus* sps.—Pale-colored mites, smaller than the head of a pin. Frequently found in grain and by-products. When abundant, they appear as loose, fluffy masses of gray powder as the cast skins are mingled with the living mites. Heat is the most effective remedy and should be used if practical. (See “Heat,” p. 94.) Fumigation with carbon disulfid may also be used. Screening or fanning may reduce the infestation to a satisfactory degree.

Granary Weevil, *Calandra granaria* Linn., and **Rice Weevil**, *C. oryzae* Linn.—Small brown weevils not over one-sixth inch in length, attacking the grain in storage. Fumigate with carbon disulfid, 10 to 30 pounds to 1000 cubic feet of air space, according to the tightness of the container. The temperature must be at least 70° F. for satisfactory results. Hydrocyanic acid gas may also be used as a fumigant, in which case from 1 to 4 ounces of pure sodium cyanid to 100 cubic feet of air space should be used. Heating the grain to 125° F. for several hours will kill all the weevils. Keeping the grain dry and well ventilated will largely prevent weevil attack in storage.

Grasshoppers.—See “General Subjects.”

GRAPE, RAISIN

Coulure.—In certain varieties notably Muscat, the flowers sometimes fail to set fruit. Interplanting with other varieties to improve pollination is recommended. Also vigorous sulfuring during blossoming to prevent mildew favors the setting of fruit.

Crown Gall=**Black Knot**, *Bacterium tumefaciens* S. and T.—Rough galls form on canes and trunks above ground; often serious. Girdled stems become weakened and die. Bad in cold situations and following frosty seasons. If spoiled parts are removed in time, new shoots will grow up from below. Control not worked out, but something can be done by surgery. Bordeaux spray in winter should be tried as preventive. See “General Subjects,” p. 55.

Little Leaf, Apoplexy, Black Measles, Obscure Diseases.—See “Physiological Diseases,” p. 57, under “General Subjects.”

Mildew, *Uncinula spiralis* B. & C. = *U. necator* (Schw.) Burr.—White mycelium spreads over young leaves, canes and fruits, checking growth; the leaves are deformed and may drop; the surface of the fruit hardens and darkens and the fruit often cracks, or may drop. Dust with sulfur when the shoots are about 6 inches long and again just before the blossoms open, being careful not to miss a single leaf. If the vines were affected the previous year do not wait until the mildew appears. In cool or moist locations a third sulfuring when the grapes are as large as peas and a fourth when they are two-thirds grown may be necessary. In these later treatments the sulfur should be dusted only on the fruit and the centers of the vines. If the larvae of leaf-hoppers are present use nico-sulfur instead of sulfur.

Achemon Sphinx Moth, *Pholus achemon* (Drury).—Large green and pinkish caterpillars with oblique whitish bars on the sides. Often abundant and doing great damage by stripping the vines. Adult moths dull gray with brown marks and pink hind wings. Spray vines with arsenate of lead (Formula 2), to which is added 1 pint of 40 per cent nicotine sulfate to every 200 gallons, or dust with powdered arsenate of lead, 1 part to 4 parts of hydrated lime or flowers of sulfur.

Armyworms and Cutworms.—See “General Subjects.”

California Grape Root Worm, *Bromius obscurus* (Linn.)—The adult beetles are black or brown and three-sixteenths inch long. They eat long slender holes in the leaves. The small white grubs feed on the roots of the vines. Cultivate thoroughly close to the vines during the winter to kill hibernating larvae. As soon as the beetles appear in the spring spray with arsenate of lead, 6 pounds of paste or 3 pounds of powder to 100 gallons of water, or dust with 1 part of powdered arsenate of lead to 4 parts of hydrated lime or sulfur.

Dried Fruit Beetle.—On raisins, see “Prune.”

Grape Leaf-hopper, *Erythroneura comes* (Say).—The immature forms or nymphs are white or pale yellow, while the adults are pale yellow with numerous small reddish marks all over the dorsum. All forms feed on the under side of the leaves, causing them to turn yellow and drop prematurely. Clear weeds and refuse from around the vineyards and practice clean culture to reduce the number of overwintering adults. Before the young nymphs develop wings spray thoroughly with nicotine and soap (Formula 27), or with the following: 40 per cent nicotine sulfate, 1 pound; liquid soap, $\frac{1}{3}$ gallon (hard

soap, 2 pounds); water, 200 gallons. The young and adults may also be killed by thoroughly dusting with a 10 per cent nicodust, or a 6 per cent nicosulfur dust, which latter will also control mildew.

Grape Phylloxera, *Peritymbia vitifoliae* (Fitch).—The presence of the phylloxera is indicated by weak and dying vines. It usually occurs in spots. The insect is a minute, yellow louse which feeds on the roots. To disinfect cuttings or rootings before planting, dip in hot water 122° F. for five minutes. For permanently resistant vines, graft European varieties on certain American roots. (See Circular No. 226, Calif. Agr. Exp. Sta., Univ. of Calif., Dec., 1920.)

Grasshoppers.—See “General Subjects.”

Indian Meal Moth.—On raisins, see “Prune.”

Mealybug, *Pseudococcus maritimus* Ehr. = *P. bakeri* Essig.—Easily distinguished by the small oval, flat bodies covered with white cotton-like wax and by the cottony egg masses among the bunches of grapes. Difficult of control, but best results have been obtained by burning sulfur under a tent over the vines. (See Monthly Bull., Cal. State Dept. Agr., Sacramento, Vol. IX, p. 26, 1920). Also see “Pear.”

HOLLYHOCK

Rust, *Puccinia malvacearum* Mont.—Prominent red sori or pustules push out on the lower surface of the leaves and on petioles and stems, often causing distortion. Fertilize and water freely to promote vigorous growth.

Destroy all old plants and start anew from seed at least every two years. Some strains appear to be resistant.

The Painted Lady Butterfly, *Vanessa caryae* Hubn.—The yellowish or black spiny caterpillars, which are about one inch long, feed on the leaves, which they draw together with webs for protection. Control is best accomplished by using 40 per cent nicotine sulfate, 1 part to 600 parts of water, and spraying the plants thoroughly.

HOP

Hop Aphis, *Phorodon humuli* (Schr.).—A pale green aphid attacking the young shoots and leaves. Dust thoroughly and as often as necessary with 5 per cent nicodust or spray until injury ceases with nicotine and soap (Formula 27.)

Hop Flea Beetle, *Psylliodes punctulata* Mels.—A small green or bronze metallic beetle, one-tenth inch long, attacking the foliage.

Jumps quickly when disturbed. The most efficient method of control consists in putting tanglefoot bands around the bases of the vines and around the poles. These not only prevent the beetles from climbing the vines but catch great numbers of them.

Red Spider or Two-Spotted Mite.—See “Bean.”

LAWNS

Earth Worms.—Earth worms or angle worms frequently cover golf greens with casts of earth, which are undesirable in such a place. To cause the worms to come to the surface, apply corrosive sublimate, mixed as follows, and then sweep up the worms and remove them:—

1 lb. corrosive sublimate.

1 gallon boiling water.

Let cool for one hour; then add 4 gallons of cold water. Use 2½ pints of this solution to a barrel of water, and apply to greens with a sprinkler. See p. 90 for precautions in the use of corrosive sublimate. This is a dangerous poison.

Weeds.—Fertilize well. Use a solution of nitrate of soda, strong enough to kill the tops but not the roots—about 3 to 5 pounds to 100 gallons of water, depending on the kind of grasses in the lawn.

Wireworms.—Lime water applied to the brown places in the lawn will drive out wireworms.

LOQUAT

Pear Blight, *Bacillus amylovorus* (Burr.) Detoni.—Limb and body blight is sometimes very severe. See “Pear.”

Scab, *Fusicladium eryobotryae* Siala.—Resembles scab of pear and apple, but is more injurious to expanding foliage. (See “Pear.”) Control is not developed but sprays for pear in foliage may probably be used.

Green Apple Aphis.—See “Apple.”

San José Scale.—See “Apple.”

MELON (Casaba, Cantaloupe, Pumpkin, Squash, Watermelon).

Blossom End Rot.—Is presumably associated with soil or climatic conditions. Sometimes severe. There is indication of resistance in some varieties.

Wilt, *Fusarium* sp.—Well-grown watermelon plants wilt and die, leaving the field nearly bare. Plant on fresh soil. Watermelons cannot be grown for several years on infected ground. Other melons are not often, if ever, affected in California.

Flea Beetles.—See “Cucumber.”

Melon Aphis, *Aphis gossypii* Glover.—A small, dark green louse occurring in great numbers on the plants and doing great damage. Destroy first infested plants as soon as discovered in spring or spray with nicotine sulfate, 40 per cent, 1 part to 1000 parts of water. A 5 per cent nicodust also gives very good results and is much more easily and quickly applied.

Nematode.—See “General Subjects.”

Squash Bug, *Anasa tristis* De Geer.—The young bugs are gray with black antennae, legs, and thorax; the adults of a uniform dull grayish-brown above, mottled yellowish beneath, and about three-quarters inch long. Control measures should be directed against the immature forms, and consist in the use of 1 part of 40 per cent nicotine sulfate to 600 parts of water. A 10 per cent nicodust kills many. Hand picking the adults in the spring is successful in small gardens.

Western Twelve-Spotted and Striped Cucumber Beetles.—See “Cucumber.”

NURSERY STOCK

Failure to Grow After Planting in Orchard.—Very rarely due to specific disease. Usually caused by freezing, drying, or water soaking of trees before or after planting; planting too deep; cold, wet, or hot weather after planting; or some other condition unfavorable to growth. Bare roots are very sensitive to slight freezing and injured trees at best start tardily and grow in a sickly way. Buy from the nearest reputable nursery. Pay for good trees and see that they are handled and planted carefully. Replant all that do not grow well the first season.

Citrus Trees.—For scale insects, defoliate and fumigate with hydrocyanic acid gas. (See p. 89.) Rejecting infested stock is the only safe procedure.

Deciduous Trees.—For borers and other insects, fumigate with hydrocyanic acid gas. Rejecting infested stock is the only safe procedure.

Nematode, Crown Gall.—Very carefully avoid planting affected trees. If a large percentage of a plot of trees is affected, those apparently healthy are of doubtful value. See “General Subjects.”

Pythiacystis Canker or Brown Rot of Lemon, *Pythiacistis citrophthora* S. & S.—Dead spots up to several inches long develop on the trunk or branches, mostly above the bud union. Caused by soil infection under very wet conditions. Spray trees with Bordeaux mixture before digging and after healing in. Soil for healing in should be well drained or under cover. Active only in very wet seasons.

OAT. See Grain

OLIVE

Armillaria, Wood Decay.—See under “General Subjects,” p. 53.

Die-back = Exanthema.—Bushy phase characterized by repeated death of terminal buds and branching out below; leaves show deformities. In die-back phase there is usually dropsy-like puffing of bark on branches and limbs and unusual prominence of lenticels in the smooth bark, with dying back. Secure uniform moisture and good drainage. Add organic material to soil by green manure crops, mulch, or manure. Replace olives with plums, peaches, or other crop where die-back is very bad. See “Physiological Diseases,” under “General Subjects.”

Dry Rot, Bitter Pit.—Dry spots appear in the flesh of the fruit. (See “Physiological Diseases,” under “General Subjects.”) No effective treatment known except good general care.

Olive Knot = Tuberculosis, *Bacterium savastanoi* E. F. Smith = *Pseudomonas oleae*.—Rounded, rough swellings, from very small up to several inches in diameter, appear on twigs, limbs, trunk, or roots, mostly at leaf scars or wounds, also rarely on fruit pedicels and leaves. Cut out thoroughly at first appearance and disinfect. (See “Pear Blight” and “Crown Gall.”) The Mission is more resistant than the Manzanillo or some oil varieties.

Peacock Spot, *Cycloconium oleaginum* Cast.—Blackish round spots, one-eighth to one-quarter inch in diameter, on the surface of green leaves but not killing the darkened area. Is apparently of very slight importance in California.

Black Scale, *Saissetia oleae* (Bern.).—See “Apricot.” Attacking chiefly the twigs. Spray with distillate emulsion (Formula 23) or miscible oil, December to February.

Branch and Twig Borer, *Polycaon confertus* Lec.—See “Apricot.” This is often a serious pest of young olive trees.

Ivy or Oleander Scale, *Aspidiotus hederae* Vall.—A small circular, flat, gray scale occurring on the leaves and fruit, sometimes causing discolored spots on the ripening olives. Control as for black scale.

Olive Bark Beetle, *Leperisinus californicus* Swaine.—The small white larvae work in the cambium layer just under the bark and the adults bore small, round exit and entrance holes through the bark. Occurs in the southern part of the state. Burn prunings and remove all dead and infested portions of the trees.

ONION

Downy Mildew, *Peronospora schleideni* Ung.—Areas on leaves or stems show a violet-tinted fuzz. These areas rapidly fade and collapse if the weather is moist, and the disease may spread rapidly. Not successfully controlled in wet seasons. Bordeaux mixture found useful in some cases; it should be used with resin fish-oil soap or other spreader. See "Spreaders," pp. 68-69; also "Asparagus."

Pink Root, *Fusarium mali* Taub.—Young plants are stunted and older plants are injured, bulb formation is interfered with and the crop reduced. Roots diseased turn pink. Avoid infected soil, or if not entirely possible keep plants growing as well as possible at all times. Where plants are grown in a seedbed and transplanted, use healthy soil, or disinfect with formaldehyde or steam, p. 95.

Scullions.—Plants fail to form bulbs, the stalks remaining thick and green. May be due to poor seed or to a check in growth. Plant at a suitable season so that development may be continuous. Cutting off seed stalks and breaking over tops when crop is maturing may help.

Armyworms and Cutworms.—See "General Subjects."

Onion Maggot, *Hylemyia antiqua* Meig.—Small, white maggots attacking the onions beneath the ground. Practice clean culture and destroy all refuse onions in the fall. Plow and cultivate thoroughly during winter and spring. Considerable protection is gained by spraying the plants repeatedly with carbolic acid emulsion. (Formula 26, diluting stock solution 1 to 40.)

Onion Thrips, *Thrips tabaci* Lind.—Minute, slender, pale yellow insects occurring in great numbers on the leaves, causing them to turn gray and wither. Spray with 1 part of 40 per cent nicotine sulfate to 800 parts of water or apply 5 per cent nicodust.

Wireworms.—See "General Subjects."

PEA

Bacterial Blight or Bacteriosis, *Pseudomonas pisi* Sack.—Extensive, watery, olive green blisters appear on stems and leaf bases in wet weather, following cold. Some affected areas dry up, others kill the stem. Where the injury does not go too far down, new stems grow from below. In some wet situations practically every plant has been killed. Control not developed, but the trouble is worse in cold wet situations.

Blight or Spot, *Mycosphaerella pinodes* Berk. & Blox.=*Ascochyta*.—Sunken dead spots form on pods, leaves, and stems, one-quarter inch or less in diameter; center of spot on pod becomes gray or pinkish, with a dark border; on leaf and stem spots are more often merely dark. Young stems may be killed. Experiments indicate spraying is impractical. Keep pea crop and diseased material off the land for two years. Seed infection rare in California. Avoid too low, wet land.

Downy Mildew, *Peronospora trifoliorum* De Bary.—Resembles downy mildew of Alfalfa. (See p. 1.) Common at the close of the rainy season, but apparently not serious.

Mildew or Powdery Mildew, *Erysiphe polygoni* D. C.—Powdery white growth spreads over the foliage, injuring plants. Troublesome in summer or when rains are light or lacking. Dust with sulfur on first appearance or nicosulfur dust if aphids are abundant, and repeat if necessary.

Armyworms and Cutworms. See "General Subjects."

Pea Aphis, *Macrosiphum pisi* (Kalt.).—A large green aphid attacking the terminal shoots and leaves of the vines. It is difficult of control because of the expense involved, but may be killed by repeated applications of a 10 per cent nicodust or a nicotine spray (Formula 27a) or a 6 per cent nicosulfur dust to also control mildew.

Pea Weevil, *Bruchus pisorum* Linn.—A small gray and white weevil attacking the pea, much as the bean weevil attacks the bean, but the pea weevil infests the peas in the field and the adults do not emerge until the following spring. Unlike the bean weevil, however, it never reinfests stored peas. Treatment is the same as for bean weevil. See "Bean."

PEACH

Armillaria, Wood Decay, Crown Gall, Nematode.—See “General Subjects,” p. 53.

Brown Rot, *Sclerotinia cinerea* (Bon.).—See “Apricot.” Sometimes causing decay of late-ripening fruit in moist regions near the coast. Control for the fruit-rot stage recommended in Eastern states consists of spraying of self-boiled lime-sulfur (Formula 15A). The last application should be made a month or more before picking so that the stain will not remain on the ripe fruit.

Leaf Curl, *Exoascus deformans* Fel.—Young leaves are attacked and become much thickened and ruffled. Tips of shoots are sometimes similarly affected and rarely areas on fruit. Affected tissue is light or highly colored; it becomes powdery white and dies early in the summer. Trees may be much injured by loss of foliage. Sprays for blight should control this, or, if blight is not present, only the spring application need be made. Some failures in control may be due to too late application of spray.

Little Leaf.—See “Physiological Diseases,” p. 57, under “General Subjects.”

Peach Blight, *Coryneum beijerinckii* Oud.—See also “Apricot,” “Almond,” “Cherry.” Buds are killed during winter, sunken round spots are killed in one-year twigs, and in spring a shot-hole effect appears on young leaves; later the twig spots gum profusely and gradually heal over unless the twig is killed. Very serious in interior valley and foothill districts in moist winters. Spray with Bordeaux (Formula 9), or lime-sulfur 1-10 between November 15 and December 15. Repeat with lime-sulfur or Bordeaux when buds swell and before first blossoms begin to open. Peaches cannot be sprayed with these materials after the leaves appear without danger of serious injury.

Powdery Mildew, *Sphaerotheca pannosa* var. *persicae* (Wallr.) Lév.—Young foliage becomes covered with white powder and growth may be checked. Large powdery white areas may appear on the fruit and later turn dark and check. Spray with lime-sulfur, as for leaf curl. Prune to thin foliage. Dust with sulfur at first indication of mildew and repeat as necessary.

Rust, *Transchelia punctata* (Pers.) Arth. = *Puccinia pruni*, Pers.—Sometimes causes trouble in the canneries through interfering with peeling of fruit, small hard spots remaining in the surface. See “Almond,” “Apricot,” “Plum.”

Black Peach Aphis, *Aphis persicae-niger* Smith.—A shiny black aphid occurring in great numbers on the young tender shoots. Spray with nicotine and soap (Formula 27) or dust with 5 per cent nicodust as soon as the insects appear.

Black Scale.—See “Apricot.”

Branch and Twig Borer, *Polycyon confertus* Lec.—See “Apricot.”

Brown Apricot Scale.—See “Apricot.”

California Peach Borer, *Aegeria opalescens* Hy. Edw.—White caterpillars attaining a length of one and one-half inches which burrow under the bark at the base of the trees, often extending their tunnels down into the bases of the main roots. Often serious, as they may completely girdle the trees. Dig out the worms carefully in the fall and spring and paint over the wounds with a good asphaltum paint. Use para-dichlorobenzene in summer and fall. See methods of treatment p. 80.

Cankerworms.—See “General Subjects.”

Flat-Headed Apple Tree Borer.—See “Apple.”

Peach Rust Mite, *Phyllocoptes cornutus* Banks.—A microscopic mite causing a silvering of the leaves. Spray in winter when the trees are dormant or when buds swell in the spring with lime-sulfur 1-10 to kill mites hibernating in buds.

Peach Twig Borer, *Anarsia lineatella* Zeller.—A small, dark-reddish caterpillar, scarcely one-half inch long, which burrows into and kills the young tender tips of the twigs and, later on, may infest the fruit to some degree. The minute young forms hibernate in small cells in the bark and are effectively killed in the early spring of the year with lime-sulfur 1-10 applied just as the blossom buds begin to open, which is before the larvae are able to enter the expanding leaf buds.

The investigations carried out by W. P. Duruz have led to the following more complete recommendations for the control of the peach twig-borer on peaches and apricots:

1. Spray with commercial liquid lime-sulfur at the rate of 1 gallon to 9 of water, plus basic arsenate of lead powder, 3 pounds to 100 gallons, in the spring at the pink stage, that is, just previous to blossoming. This combination will control diseases and insect pests other than the peach twig-borer. Because of the frequent damage resulting from lime-sulfur in coastal districts, it is considered best not to use this spray on apricots. Therefore Bordeaux mixture, 7-8-50, plus basic arsenate of lead, 3 pounds to 100 gallons,

seems to be the best combination for apricots when brown rot or shot-hole fungus and peach twig-borer are to be controlled. This later spray also should be applied at the pink stage.

2. Nicotine sulfate, $\frac{3}{4}$ of a pint to 100 gallons of water, with 3 pounds of soap as a spreader, is a good remedy for the peach twig-borer, and may be used alone in a few limited cases where diseases and other insects are not troublesome. This is specially recommended for apricot trees which may be injured by lime-sulfur or arsenical sprays.

3. A summer spray of arsenate of lead, *basic* or *neutral* (never acid), at the rate of 3 pounds to 100 gallons of water with $\frac{3}{4}$ pounds of casein spreader, may be used as an additional insurance against "wormy" fruit. This spray should be applied not less than two weeks before the fruit is picked.

4. Too much emphasis cannot be placed upon the necessity of proper spraying at the right time. It is essential to cover the entire surface of the tree, particularly the newer and outer portions of the branches. Use at least 175 pounds pressure and preferably 250 pounds.

5. All prunings should be collected and particularly the small and newer wood should be burned before spring, because this material harbors the larvae.

6. Cull fruit should not be carelessly left about the orchard or packing house. All wormy fruit should be collected and properly disposed of. It should be fed promptly to pigs or other stock, or destroyed by burning or burying. A quick and simple manner of destroying worms in the cull fruit is to place the discarded fruit in a pile or in a trench, saturate with oil or cover with wood, and ignite. The heat resulting from the fire will be sufficient to kill the larvae in the fruit. Another means of destroying the larvae is to place the cull fruit in a caldron of boiling water for 15 minutes.

Red Spider.—See "Almond" and "Prune."

San Jose Scale.—See "Apple."

Shot Hole Borer.—See "Apricot."

Tent Caterpillars.—See "General Subjects."

Wheat Thrips, *Frankliniella tritici* (Fitch).—This minute orange and yellow thrips often does considerable damage to the young fruit at blossoming time and later. For control see pear thrips under "Pear."

COMBINED SPRAYING

Two applications of lime-sulfur as recommended above for peach blight will control all of the usual diseases and pests of the peach in California which can be reached by any spray treatment, but lime-sulfur has occasionally been reported as causing injury when applied in the bloom and may not be effective for control of leaf curl when applied late.

PEAR

Black End.—Is presumably a physiological disease comparable to blossom end rot of tomatoes. No recommendation as yet except to give good care, especially as to drainage.

Black Leaf.—Resembles blight in effect; bark, however, is not reddish and juicy when cut into, but with dry black spots or areas. (See "Sour Sap," under "General Subjects.") Shallow soil and summer drought appear to have particular significance in connection with this trouble. A peculiar condition sometimes develops on individual trees in which dark points develop in one-year bark. These persist and become hard, raised and enlarged until the whole surface may be much roughened and hardened. In certain dry soils in the south a peculiar drying back of twigs occurs. The drying progresses to a certain point and new shoots start out below. Making the moisture supply of the soil more constant is believed to have greatly helped this condition. See "Sour Sap," p. 57.

Blight, *Bacillus amylovorus* (Burr.) Detoni.—Tender growth becomes watery, darkens rapidly, wilts, and dies; usually minute beads of viscid material exude; they dry in the same form and show a solid mass of bacteria under the microscope when moistened in water; in heavier bark the exudate may be more copious, or it may be lacking; the diseased tissue may be recognized by cutting into it. Watery, reddish, or somewhat dark streaked areas indicate blight. Any succulent part of the top, body or root may be attacked. Cut out all affected parts very thoroughly. Work especially on "hold-over" in large limbs, trunks, and roots during the winter. Disinfect tools and cuts freely. A new system is being largely used in which only the outer bark is cut away, leaving the cambium. Keep close watch to check new development of infection. Mercuric cyanid and corrosive sublimate combined, 1 part of each to 500 of water* (Formula

* Mr. Leonard Day of our Pomology Division recommends instead of water in the above formula 1 part water in 3 parts glycerine. The disinfectants are dissolved in the 1 part of water and the 3 parts of glycerine added. Hot water dissolves the chemicals more readily than cold. This spreads and penetrates better than the water solution.

28a, p. 90), is widely used for disinfection. Keep all suckers and spurs off of root and body. In new plantings in blight regions, top-work on resistant varieties. Surprise, Ussuriensis, and others are being used and promise well.

Avoid stimulating excessive and succulent growth. Clean up or destroy infected apple, quince, loquat, christmas berry and related plants in the neighborhood.

Scab, *Venturia pyrina* Aderh. = *Fusicladium*.—Dark, velvety mold patches appear on young fruit and leaves; badly affected fruit drops, but much remains, the dark areas becoming hard and rough and often cracked, deforming the fruit. Plow under all old leaves as thoroughly as possible. Spray with lime-sulfur 1 to 12, or Bordeaux (Formula 9) just as the winter buds first loosen to show the individual flower buds. Repeat just before the first flowers open. Where there is danger of late scab infection, follow directions under "Combined Spraying."

Many varieties of pears are self-sterile or partly or occasionally so. Cross pollination is sometimes essential and perhaps always beneficial for the Bartlett. Frost may cause flowers to drop or fruit to develop russet areas or bands. Premature starting of blossom buds from unfavorable conditions may simulate thrips injury, causing them to be loose and dry in winter and to come out imperfectly in spring. Glut morceau fruit becomes injured and deformed or drops, apparently from cold, when others are not injured.

Baker's Mealybug, *Pseudococcus maritimus* Ehrh. = *P. bakeri* Essig.—Small, oval, flat insect less than one-quarter inch long and covered with white powdery wax and normally with several white, tail-like filaments nearly half as long as the body. The egg sacs look like small masses of cotton. The insects occur under the bark, on the under side of limbs, in cracks, wounds, and in the blossom end of the fruit. Control measures are difficult and consist of repeated applications of crude carbolic acid and distillate emulsion (Formula 26a) during the winter months and until the buds begin to open in the spring. Scrape the rough bark from the trunks and larger limbs so as to expose the mealybugs to the spray. If the fruit is infested, spray during the summer with water under heavy pressure to wash the bugs away.

Branch and Twig Borer.—See "Apricot."

Brown Apricot and Other Soft Scales.—See "Apricot."

Cankerworms.—See "General Subjects."

Cherry or Pear Slug.—See "Cherry."

Codling Moth.—See “Apple.” The control of this insect on pears is not so difficult as on apples, but thorough work is necessary to insure clean fruit, particularly in districts where large acreages of pears are grown.

Fruit Tree Roller.—See “Apple.”

Green Apple Aphis.—See “Apple.”

Italian Pear Scale, *Epidiaspis piricola* Del G.—A small, gray, circular scale, the body being dark red, usually occurring under the moss or old bark; but it may cover the trunks and all of the main branches of the tree. Causes sunken areas in old limbs and greatly weakens the tree. Spray in the winter months, preferably in January and February, with crude oil emulsion (Formula 18), distillate sprays (Formulas 20 to 23), or miscible oils. The crude oil emulsions are preferable. Thoroughly drench the limbs and trunks. (See Cir. No. 224, Calif. Agr. Exp. Sta., Univ. Calif., Dec., 1920.)

Pear Leaf Blister Mite, *Eriophyes pyri* (Pagen.).—A microscopic mite causing pinkish and yellowish blisters or marks on the young terminal leaves and occasionally reddish blotches on the young fruit. Spray in November or February with lime-sulfur 1-10 to kill hibernating mites in buds.

Pear Root Aphis, *Eriosoma lanuginosa* (Hartig).—A small dark aphid covered with white cottony material and greatly resembling the woolly apple aphis, but attacks only the pear roots. For control see woolly aphis under “Apple.” Eliminate young stunted trees and replant healthy ones. The Japanese root is much more resistant to this pest than the French. Use para-dichlorobenzene in fall. See p. 80.

Pear Thrips, *Taeniothrips inconsequens* Uzel.—Small, slender, black insect one-sixteenth inch long, appearing before or at the time the blossom buds begin to open and continuing until after blooming season. The young or white thrips work in the late blossoms, but chiefly on the young fruit and leaves. Spray as often as necessary with the government formula (Formula 24) or dust repeatedly with 5 per cent or 6 per cent nicodust. Watch for adult black thrips as soon as the buds begin to open and apply control measures as soon as any number of the insects appear. (See Cir. No. 223, Calif. Agr. Exp. Sta., Univ. Calif., Nov., 1920.)

Red Humped Caterpillar.—See “Prune.”

San Jose Scale.—See “Apple.” Treatment for the Italian pear scale above will also suffice for this insect.

COMBINED SPRAYING

1. For scale of any kind and for moss and a general clean-up, use a winter spray of lime-sulfur 1-10, crude oil emulsion (Formula 18), or miscible oil.

2. For scab and thrips use Bordeaux mixture (Formula 9), or lime-sulfur 1-12 as cluster buds are opening, adding an extra 10 pounds of lime and 1 pound of 40 per cent nicotine sulfate to each 200 gallons of spray. Oil sprays should not be mixed with lime-sulfur or Bordeaux mixture for this purpose.

3. For scab and thrips, repeat "2" when first blossoms are about to open.

4. For codling moth and late scab infection, spray when petals are falling with 8 pounds of lead arsenate in 200 gallons of 1-30 lime-sulfur or 200 gallons of Bordeaux mixture.

PLUM, PRUNE

Armillaria, Wood Decay, Crown Gall, Sour Sap and Physiological Diseases.—See "General Subjects," p. 53.

Brown Rot.—Not often serious. See "Apricot."

Leaf Spot, *Coryneum beijerinckii* Oud.—See "Apricot," "Peach." and "Almond."

Plum Pockets, *Exoascus pruni* Fcl.—This disease is as yet very local. Young fruits puff up early, becoming large and bladdery, then wither and fall. Remove all diseased fruits and twigs and burn. Spray as for leaf curl of peach.

Rust, *Transchelia punctata* (Pers.) Arth.=*Puccinia pruni* Pers.—Small, dark brown, powdery dots appear on the lower sides of leaves with corresponding yellow dots above. Not observed to be serious.

Unfruitfulness.—See also under "Pear" and "Almond." The University's Division of Pomology is adding constantly to our knowledge of the relations of varieties for efficiency in cross fertilization. Growers should keep carefully posted on these results. Varieties may be wrongly chosen, bees may be lacking, premature starting and failure of buds may occur.

Black Scale.—See "Apricot."

Brown Apricot Scale.—See "Apricot."

Branch and Twig Borer.—See "Apricot."

California Peach Borer.—See "Peach."

Cankerworms.—See "General Subjects."

Cherry Fruit Sawfly.—See “Cherry.” Also attacks varieties of plums.

Citrus Red Spider, *Tetranychus citri* McGregor.—See “Common Red Spider,” p. 44.

Dried Fruit Beetle, *Carpophilus hemipterus* (Linn.).—A small black beetle less than one-quarter inch long with a reddish spot near the middle of the dorsum. The adults and small yellowish or whitish larvae feed on the dried fruit and continue to breed indefinitely in storage. They may be controlled by fumigation as recommended for grain weevil. See “Grain.”

Flat-Headed Apple Tree Borer.—See “Apple.”

Fruit Tree Leaf Roller.—See “Apple.”

Indian Meal Moth, *Plodia interpunctella* Hübner.—The caterpillars are white or pinkish and about one inch long. They feed on the dried fruit, through which they work their way to all parts, leaving behind a trail of excrement, webbing, and spoiled fruit. Their presence is usually first indicated by webbing on the fruit or around the sides of the container. The adults are small, slender, silvery gray moths with the apical ends of the wings coppery. This insect is controlled in the same way as the granary weevil. (See “Grain.”) Dipping the fruit in scalding water prior to packing kills all forms of this insect. Small packages of dried fruit should be made insect proof to prevent infestation in warehouses and storerooms.

Italian Pear Scale.—See “Pear.”

Mealy Plum Louse, *Hyalopterus arundinis* (Fabr.).—A pale green aphid covered with a fine white mealy wax; it collects in great numbers on the under side of the leaves of tender shoots in May and June. Spray with 6 pounds of fish oil soap to 200 gallons of water, or use nicotine soap spray. (Formula 27.) The soap alone appears to give as satisfactory results as the nicotine soap spray and is much cheaper.

Peach Twig Borer.—See “Peach.”

Pear Thrips.—See “Pear.”

Red-Humped Caterpillar, *Schizura concinna* S. & H.—The caterpillars are beautifully lined, reddish, black and yellow with a conspicuous red hump on the back. They feed in large colonies and may entirely defoliate individual limbs or entire trees during the spring and again in the fall of the year. They spin no webs and are not to be confused with the tent caterpillars which appear in the spring and the webworms, in the fall. Control measures consist in cutting out and burning the entire colonies when small or in spraying with arsenate of lead as for codling moth or better in dusting the infested trees with 1 pound of powdered arsenate of lead

thoroughly mixed with 4 pounds of hydrated lime. The dusting may be effectively done with either a hand or power machine.

Red Spider or Almond Mite.—See “Almond.”

San José Scale.—See “Apple.”

Tent Caterpillars.—See “General Subjects.”

Common Red Spider, *Tetranychus telarius* Linn.—This small, pale green or yellow mite, with from two to six dark spots on its back, appears in mid and late summer and does great damage to plum and prune trees by causing the leaves to fall prematurely. Dusting and spraying as recommended for the almond mite (see “Almond”) should be done very thoroughly and continued until the first good rains occur in the fall.

Tussock Moth.—See “Apple.”

COMBINED SPRAYING

For scale, moss, and a general clean-up, spray in winter with crude oil emulsion. (Formula 26.)

POTATO

Black Heart.—Dark clouded areas appear in the flesh and may dry out, leaving cavities. Due to high temperature or lack of oxygen or the two combined. Occurs mostly in storage, but may develop before digging.

Brown Streak.—Tubers show a brown ring or streaks in the flesh when cut into. Apparently due to climatic conditions—high temperature and drought. Affected seed may produce a healthy crop. See “Physiological Diseases,” p. 57.

Jelly End, Soft Rot, Leak.—Very soft or watery rots; are due to infection in wounds with several fungi, *Pythium*, *Rhizopus*, etc. Avoid injury and bruising in digging.

Potato Late Blight, Late Rot, *Phytophthora infestans* (Mont.) De Bary.—Translucent spots appear on the leaves and stems, which spread rapidly till entire top is wilted and prostrate. The tubers show sunken spots at digging and rot in storage. Spray with Bordeaux mixture (Formula 9) immediately after rains.

Rhizoctonia or Black Scurf, *Corticium vagum* B. and C. = *Rhizoctonia*.—Dark, reddish-brown scabs are found on the tubers. These may be scraped off, leaving the surface smooth. Underground parts are killed in some cases, destroying plants, reducing the number of tubers, or causing various symptoms in the tops, sometimes with aerial tubers. The fungus is of widespread occurrence in soil and attacks many plants. See “Beans,” “Damping Off,” p. 55, etc.

For tuber diseases in general secure seed from healthy fields and reject any tubers showing appreciable amounts of scab, rhizoctonia, wilt (as shown by dark fibres in section of the stem end) or other suspicious symptoms. If scab and rhizoctonia are feared, dip in a solution of corrosive sublimate (Formula 28, p. 90) for 1½ hours before cutting. This solution should be placed in wooden or earthenware (not metal) containers and should be used only 4 or 5 times; also the potatoes should be clean as possible before dipping. Do not use potatoes treated with corrosive sublimate for food. If only scab is feared, the tubers may be dipped in a solution of formaldehyde, 1 pound to 30 gallons of water for 2 hours. The solution may be used repeatedly, and is not spoiled by contact with metal.

Potato pathology in recent years has become highly intricate and control measures must be adapted to local conditions. Healthy seed, rotation of crops, preparation of soil and management are of great importance. See your farm advisor and authorities on potato culture.

Scab, *Actinomyces scabies* (Thaxter) Güss. = *Oospora*.—The common rough, corky spots in the surface of tubers which are made unsightly. Underground parts of the growing plant are also injured to some extent. Said to be favored by alkaline soil, or the addition of lime or manure in excess, and retarded by the plowing down of a green cover crop. Use clean seed and dip in a fungicide. See "Rhizoctonia."

Wilt and Dry Rot, *Fusarium* sp.—Plants are affected as in severe drought, the leaves ripening prematurely. Tubers appear sound, but often show a ring of darkened fibres when the stem end is cut across. Low temperature in general retards rot associated with wilt. So far as possible, use seed from healthy fields.

Aphids (Various Species).—Dust thoroughly with 5 per cent nicodust or spray with 1 part of 40 per cent nicotine sulfate to 800 parts of water.

Armyworms and Cutworms.—See "General Subjects."

Flea Beetles and Leaf Beetles.—See "Melon." Use Bordeaux mixture (Formula 9) as a repellent, or a nicodust lead arsenate mixture.

Garden Nematode or Eelworm.—This microscopic round worm produces a pimply or warty surface on the potato and small brown dots just beneath the skin. Plant only clean seed and avoid infested soil.

Grasshoppers.—See "General Subjects."

Potato Stalk Borer, *Trichobaris trinotata* Say.—The larvae are small, pale yellow or white, and not over one-half inch long; they bore throughout the middle of the stalks, causing them to wilt and die. The adults hibernate in the old dry stalks, which should be raked up after digging and burned. This affords an almost perfect control if thoroughly done.

Potato Tuber Moth, *Phthorimaea operculella* (Zeller).—The full-grown caterpillars are white or pinkish and not over three-quarters inch long. They make numerous burrows just under the skin and throughout the tubers, continuing to work as long as the tubers are available. Infestation may occur in the field or in storage. Hill up well around the growing plants and remove the potatoes as soon as dug to prevent infestation in the field. Store in a clean, uninfested place. If infested, fumigate with 20 to 30 pounds of carbon bisulfid to every 1000 cubic feet of air space at a temperature 70° F. or over. Plant only clean seed.

Tomato and Tobacco Worms.—See "Tomato."

Wireworms.—See "General Subjects."

COMBINED SPRAYING

Bordeaux mixture will control not only the flea beetles but will materially aid in subduing many fungus diseases.

PUMPKIN. See "Melon"

ROSE

Cold Injury.—Many plants are found in spring with dark-stained leaves or small distorted and sickly foliage, due to chilling of tender tissue of shoots, which start growth too early in winter. Delay pruning until February or later. Prune rather heavily and stimulate vigorous growth by general culture measures.

Mildew, *Sphaerotheca pannosa* (Wallr.) Lév. and *S. humuli* (D. C.) Burr. = *Oidium*.—White, powdery mildew spreads over young stems or leaves, causing distortion or dropping of leaves and discoloration; severe in cool coast districts. Spray with lime-sulfur 1-10 before the spring growth starts. Use dry sulfur, sulfur paste, or lime-sulfur 1-35 when disease first appears.

Aphids (Various Species).—Two common aphids usually infest roses: the large green and pink *Macrosiphum rosae* (Linn.), which commonly attacks the tender tips and buds, and the small green *Myzaphis rosarum* (Walk.), which works on all parts of the plant and produces large quantities of honey dew, resulting in the smutting of

the plants. Both may be effectually controlled by dusting liberally with 5 per cent nicodust, by spraying with nicotine sulfate, 40 per cent, 1 part to 1000 parts of water, or by thoroughly hosing off the plants every two or three days with a strong water pressure and a coarse nozzle.

Fuller's Rose Beetle.—See "Citrus Fruits."

Raspberry Horntail.—See "Bush Fruits."

Rose Scale.—See "Bush Fruits." Spray infested portions of the plants during the winter months with miscible oils.

Rose Snout Beetle, *Rhynchites bicolor* Fabr.—A small red and black snout beetle, scarcely one-quarter inch long, which punctures the buds of roses, causing numerous holes in the petals when the flowers open. Jar beetles in pan of oil in the early mornings. A 10 per cent nicodust has given good control in some places.

COMBINED SPRAYING

For fungus diseases and aphids, a 40 per cent nicotine sulfate may be added to sulfur sprays as given above, and a sulfur nicodust may also be used for mildew and aphids.

SNAPDRAGON

Rust, *Puccinia antirrhini* D. & H.—Brown rust sori break out through the leaf and stem. Infection is usually heavy and the plant becomes unsightly and dies. Water and fertilize freely to stimulate growth. When the disease becomes severe destroy badly affected plants and clean up thoroughly in the fall. Start with clean seedlings. Pentstemon is a fairly good substitute for snapdragon, and does not rust.

Aphids.—Dust thoroughly with 5 per cent nicodust.

SORGHUM, SUDAN GRASS, AND BROOM CORN

Head Smut, *Sphacelotheca reiliana* (Kühn.) Clint.—Whole head or panicle becomes a black mass. Method of treatment not yet developed. Affected plants should be destroyed at first appearance. Affects also corn.

Kernel Smut, *Sphacelotheca sorghi* (Lk.) Cl.—Kernels form enlarged grains which become fragile and filled with a black powder. Controlled by seed treatment. See "Grain."

Aphids (Various Species).—See "Grain."

Armyworms and Cutworms.—See "General Subjects."

Granary and Rice Weevils.—See "Grain."

Grasshoppers.—See "General Subjects."

SPINACH

Armyworms and Cutworms.—See “General Subjects.” Poison bran mash sown broadcast over the fields has proved very successful in completely protecting young plants.

Beet or Spinach Leaf Miner, *Chortophila hyoscyami* Panzer.—Small white maggots mining the leaves and causing discolored areas. Keep down all weeds about the fields, burn refuse tops, harvest as early as possible. Winter-grown spinach usually escapes the attacks of this insect.

Flea Beetles.—See “Cucumber.”

Grasshoppers.—See “General Subjects.”

Melon Aphis.—See “Melon.”

SQUASH. See Melon.

STRAWBERRY

Leaf Spot, *Mycosphaerella fragariae* (Tul.) Linn. = *Ramularia*.—Dead spots on leaves, one-quarter inch or less in diameter with red borders; if abundant it lowers the vitality of the plants. Clean up and burn the leaves in late fall. Spray with Bordeaux mixture (Formula 9) if the disease becomes serious.

Leaf and Stem Rot.—Symptoms are those of acute drought injury; plants die back in hot weather and inferior growth comes up later with poor production; roots are killed off, apparently by poor soil conditions. Use less water. Improve drainage. Wash out alkali in winter by flooding.

Gray Mold, Botrytis rot.—See “Bush Fruits.”

Strawberry Aphis, *Myzus fragaefolii* Kkll.—A very small pale yellow aphid occurring in great numbers on the under sides of the leaves, and often smutting the foliage. Defoliate the plants in winter. Dust liberally with 5 per cent nicodust as soon as the aphids appear, applying it to the under side of the leaves with an upturned discharge pipe.

Strawberry Crown Moth, *Aegeria rutilans* H. Edw.—A white caterpillar one-half inch long or less boring into the crown of the plant, causing it to turn yellow and die. Remove and burn infested plants as soon as discovered. Be sure of clean nursery stock.

Strawberry Flea Beetle, *Haltica ignita* Illiger.—A bright metallic, golden, green, or purplish flea beetle, one-sixth inch long, feeding upon the leaves of the plants. Use Bordeaux mixture (Formula 9) as a repellent.

Strawberry Leaf Beetle, *Paria canella* (Fabr.).—A small brown beetle with black markings on the dorsum and averaging one-eighth inch long. The adults eat numerous small irregular holes in the leaves, while the small white larvae attack the roots. It is a severe pest, and should be eradicated, if possible, by destroying all infested vines and thoroughly sterilizing the soil by steam or carbon bisulfid. Established infestations may be reduced by thoroughly spraying with arsenate of lead (Formula 2), or by dusting with 1 part of basic powdered arsenate of lead to 4 parts of powdered hydrated lime.

Strawberry Root Weevil.—The one known infestation of *Otiorhynchus rugifrons* Gyll. in California is quarantined. Secure plants from uninfested district. Report any suspicious cases to the State Department of Agriculture, Sacramento, Calif.

Two-Spotted Mite, *Tetranychus telarius* Linn.—See “Bean” and “Prune.” Though ordinarily controlled with dry sulfur, this method cannot be used on strawberries because of the severe burning to the foliage. Very small amounts of sulfur in the ditches between the rows have afforded some relief.

SWEET POTATO

Black Rot, *Sphaeronema fimbriatum* (E. & H.) Sacc.=*Ceratocystis*.—Black spots appear on sprouts and circular black spots on surface of potatoes, with tissue below greenish. Affected potatoes are bitter when cooked. Spreads in storage. See “Wilt.”

Foot Rot, *Plenodomus destruens* Harter.—Brown to black spots appear on stems near surface of soil late in season and plants finally wilt, usually not producing potatoes. Also a brown firm rot of potatoes often starting in wounds. See “Wilt.”

Scurf, *Monilochaetes infuscans* E. & H.—A brown discoloration or spotting occurs on the surface of the potatoes rendering them less attractive and more liable to dry out in storage. See “Wilt.”

Soft Rot, *Rhizopus nigricans* Ehr.—Mainly a storage trouble; rot starts at injuries and progresses rapidly; decayed part becomes covered with white mold which later turns black. Avoid bruising. Dry well before storing. For long keeping, pack in dry sand. Moisture and temperature requirements of sweet potatoes in storage are different from those of most other products and must be carefully observed.

Wilt or Stem Rot, *Fusarium* sp.—Leaves become paler than normal; plants wilt and die; stems have the fibres blackened and this shows also in the stem end of the potato as a blackening when cut across.

Stem and root diseases of sweet potatoes require similar treatment. Hotbeds which have been used previously for sweet potatoes should be cleaned out and soaked with formalin 1 pound to 30 gallons of water. The soil used should be from some place where sweet potatoes have never been present or should be disinfected. (See p. 95.) The manure should have no remains of sweet potatoes in it. Plants and potatoes are both infectious. Where wilt is present, select seed potatoes in the field before frost, cutting across the stems and rejecting all hills which show black rings. Store all seed potatoes separate from the main crop, where contamination may not spread to them. Where diseases are serious, dip the seed in corrosive sublimate as for white potatoes (see p. 45), except that the time of soaking must not exceed 5 to 10 minutes. Where diseases become troublesome, rotate crops, planting no sweet potatoes for three to six years.

TOBACCO. See “Tomato”

TOMATO. See also “Potato”

Blossom End Rot.—Dry spot appears at blossom end of green fruit and develops slowly. Avoid drought or irregular irrigation.

Damping-off.—See “General Subjects.”

Fruit Decays.—In California due mostly to common molds which gain access in some mechanical injury and develop on the way to market. Remove all refuse fruit to a safe distance from the packing house. Avoid mechanical injuries in the fruit.

Late Blight, Late Rot, *Phytophthora infestans* (Mont.) De B.—In late moist weather large vague spots appear on the leaves, at first dark and watery, becoming slightly frosted with emerging fungus threads below, then deteriorating rapidly. Similar spots appear on the fruit, not well-marked at first, but the fruit spoils rapidly. Spray with Bordeaux mixture (Formula 9) immediately after rains.

Western Blight.—Plants become pale; leaves roll upward, exposing purplish veins; plants become worthless and most of them die. No control has been developed as yet.

Wilt, *Fusarium* sp.—Plants in the field turn yellow and die often after reaching considerable size. A dry rot is found in the stem and roots. Secure clean soil for seedbed or disinfect soil and beds. (See p. 95.) Rotate crops. Resistant varieties are being sought.

Armyworms and Cutworms.—See “General Subjects.”

Grasshoppers.—See “General Subjects.”

Darkling Ground Beetles, *Blapstinus* sp. and *Eurymetopon bicolor* Horn.—Small, dull black or bluish-black beetles, scarcely more than one-quarter inch long, living in the soil and responsible for much damage to young plants shortly after transplanting. Before resetting, wrap the stems of the young plants from roots to tops with tissue paper so as to have three or four thicknesses for protection, or scatter poison bran mash (Formula 4) over the ground at planting time.

Flea Beetles.—Dust with powdered arsenate of lead, 1 part to 4 parts of dry lime or sulfur, nicodust and arsenate of lead, or spray with Bordeaux mixture. (Formula 9.)

Garden Nematode.—See “General Subjects.”

Tomato Worm, *Protoparce sexta*, Joh. and **Tobacco Worm**, *P. quinquemaculata* Haw.—Large green worms often attaining a length of four inches. They strip the leaves from the vines. The adults are known as humming bird moths because of their large size and swift flight. They are gray with yellow spots on the sides of the body and have a wing expanse of 4 or 5 inches. The caterpillars may be controlled by hand picking, i.e., cutting the worms in two with a pair of scissors, or by dusting the vines with 1 part of powdered arsenate of lead to 4 parts of finely ground hydrated lime.

WALNUT

Blight, *Pseudomonas juglandis* Pierce.—Young tender parts are attacked. Spots at first watery, soon turning black, often spread and kill young nuts, leaves, or tender tips of shoots. No specific remedy. Give the trees the best possible care. Thin out the tops of the old trees. Control aphids. Plant resistant varieties.

Crown Gall, Wood Decay, Armillaria.—See “General Subjects.”

Melaxuma, *Dothiorella gregaria* Sacc.—Black sunken cankers develop on larger limbs and trunks; the limb may be girdled and the part above die. Cut out diseased bark areas and apply Bordeaux paste.

Winter Killing.—Irrigate about November 1, if no good rains have fallen. Whitewash trunks in the fall. Do not irrigate after August, except as above.

Codling Moth, *Cydia pomonella* (Linn.).—See “Apple.” This worm feeds on the green husks or usually bores directly into the kernel of the walnuts before they are mature, and also often works its way

into the kernel after the shell becomes hardened by making an entrance in the suture at the base. It may be controlled by spraying with basic arsenate of lead or by dusting with powdered basic arsenate of lead and hydrated lime when work on husks of nuts is first observed in the spring—May, June, or July—depending upon climatic conditions due to location near the coast or inland. Consult local horticultural officials.

Frosted Scale, *Lecanium pruinosum* Coq., and **Cherry or Calico Scale**, *L. cerasorum* Ckll.—Same control as for brown apricot scale. See “Apricot.”

Indian Meal Moth.—Attacks walnuts in storage. See “Prune.”

Nautical Borer, *Xylotrechus nauticus* Mann.—The borers are small, fleshy, white or yellowish grubs, with slightly enlarged anterior end, and about three-quarters inch long. The adult beetles are one-half inch long, dark with narrow broken yellow or whitish cross bands on the elytra. The larvae work in the small twigs, limbs, and trunks of both healthy and sickly trees. Cut out and burn all infested portions. Destroy all dead oaks or prunings in the neighborhood to eliminate breeding places.

Red Humped Caterpillar.—See “Prune.”

Two-Spotted Mite.—See “Prune.” Dust thoroughly with dry sulfur.

Walnut Aphis, *Chromaphis juglandicola* (Kalt.).—A small pale yellow aphid occurring in great numbers on the under sides of the leaves and producing great quantities of honey dew, which causes severe smutting of the foliage. Dust thoroughly with a 2 per cent nicodust during last week of May or the first part of June. Sometimes a second application is necessary in July or August.

Walnut Blister Mite, *Eriophyes erinea* Nalepa.—A microscopic mite producing yellow or brown felt-like galls on the under sides of the leaves. It is not a serious pest, but may be cleaned up by spraying trees with lime-sulfur 1-10 in the spring when the buds are swelling. Control measures are not recommended except in extreme cases.

Yellow-Necked Caterpillar, *Datana ministra* Drury.—A black, hairy caterpillar with numerous longitudinal yellow stripes on the back and sides and a yellow or orange-colored neck. It averages about two inches in length and is closely related and similar in habits to the red-humped caterpillar, and may be handled in the same way. See same under “Prune.”

WATERMELON. See “Melon”

WHEAT. See “Grain”

GENERAL SUBJECTS

ARMILLARIA ROOT ROT (OAK FUNGUS), *Armillaria mellea* (Vahl) Quel.

Caused by a native fungus which lives saprophytically and parasitically in roots of woody plants. Trees and bushes are killed in spots, which enlarge year after year. Affected trees fail gradually from diseased side or die suddenly in summer. Under the affected bark of roots there is a yellowish white fan-shaped mycelium which progresses into live bark. Black shining root-like strings (rhizomorphs) grow out from old rotting roots. The wood decays with a uniform white rot. Large tan-brown toadstools (edible when cooked) arise from old infections, October to February. Surgery as in crown gall or pear blight can sometimes be practiced on roots and crowns of trees not too far gone. Black walnut, French pear, and fig roots are practically immune. Myrobalan is more resistant than most stone fruits and something may be gained by working high on this stock. Similarly the Delicious apple on its own roots is being tried, especially for Gravenstein, which seems to be unusually susceptible. Annual fibrous rooted plants are rarely injured. Affected areas in orchard may be isolated by opening a trench 3 to 4 feet deep around them. This may be filled immediately if reopened every two years to keep the roots cut off. Nursery should not be planted in infected soil.

ARMYWORMS AND CUTWORMS

General Life History.—The adult members of this family *Noctuidae* are practically all night-flyers. The caterpillars of many are known as armyworms and cutworms and are among the most destructive of insect pests. They often advance from field to field in great numbers, like an army, devastating as they go. Like the grasshoppers, they attack practically all kinds of plants, including field and truck crops, vineyards and orchards, as well as flowers and weeds.

The adults lay their eggs in spring and the larvae become exceedingly numerous in early summer, when most of the damage is done. The pupal stage is passed under ground, the light or dark brown naked chrysalids being housed in small earthen cells. There are several broods a year. The winter is usually spent in the pupal stage, but some larvae as well as adults hibernate. A hibernating larva often seriously injures grapevines in the spring by eating the buds.

Control.—The control of these insects has been a difficult problem for years, and even today the methods worked out do not always give relief.

Clean culture in fall and thorough plowing of infested fields to kill the hibernating pupae in the cells is supposed to greatly reduce the next year's broods. This has been recommended as especially important in pea fields and gardens.

When the worms begin to march trenches may be plowed across and ahead of their paths with a perpendicular wall in front of the advance. The worms, not being able to cross, will gather in great masses in these trenches and can be easily killed by spraying with crude oil or by crushing them with a narrow disk or roller. Arsenical sprays applied as soon as the larvae begin to appear will sometimes materially aid in protecting crops like potatoes, tomatoes, young trees, grapevines, etc., but are seldom practical for forage crops.

Poisoned baits (Formulas 4 and 5) sown in the infested fields will kill countless worms, and these afford by far the most satisfactory means of killing these insects under all conditions. In fields, pastures, orchards, and gardens, the poisoned baits may be freely sown over the plants. The armyworms and cutworms will eat the bait in preference to growing vegetation.

Light traps are also used to capture the adults, but these have never seemed to greatly lessen the attacks, because large numbers of the moths captured have previously laid their eggs.

Natural Enemies.—By far the most important factors in the control of armyworms and cutworms are natural enemies. The parasitic tachinid flies kill countless numbers of them. Hymenopterous parasites of the family *Ichneumonidae* also prey upon the young. The predaceous ground beetles of the family *Carabidae* devour the worms and destroy great numbers. That armyworms and cutworms are not injurious every year is undoubtedly due to the work of these natural enemies.

CANKERWORMS

Small green or dark measuring worms less than an inch long, which feed upon the leaves and young fruit and drop down on a silken thread when the tree is jarred. The females are wingless and crawl up the trees in the fall or spring to lay their eggs on the limbs and small branches. Egg-laying on the trees is prevented by placing tanglefoot, cotton, or permanent wire screen bands around the trunks of the trees in the fall in order to catch both the fall and spring forms. The cater-

pillars are easily jarred from the trees, but will crawl up again if not obstructed. Spraying with arsenate of lead (Formula 4) will also give control.

CROWN GALL, *Bacterium tumefaciens* S. & T.

Rounded fleshy to woody tumors form on roots or sometimes on above-ground parts, usually starting from wounds, persisting and growing at the edges from year to year, often girdling or causing the tree to break off. For nurseries, avoid old vineyard, orchard, or berry land which has been seriously infected. Throw out all affected nursery trees. The clean trees in a lot having a large percentage affected are of doubtful value. In orchards, occasionally examine crown and main roots, especially of stunted trees. When not too far advanced this disease may be controlled by chiseling out the galls, removing all abnormal tissue to healthy bark and down to sound wood, sterilizing with corrosive sublimate (Formula 28 or 28a), and covering the wounds with Bordeaux paste or asphaltum. The trees must be gone over again after vigorous growth has been going on for several weeks and the new galls which arise at the wound margins treated. Reinspection is essential. Badly affected and stunted trees should be pulled out and replanted, using fresh soil.

DAMPING-OFF

Young seedlings rot at or below the surface of the ground and fall over or wilt. Many may die before emerging. Cause, various soil fungi, *Pythium*, *Rhizoctonia*, *Fusarium*, and others. Best controlled by skill in watering. Water the plant beds only in the morning and on bright days. Do not sprinkle oftener than necessary. In greenhouses or frames give plenty of ventilation. In making citrus seed beds put an inch or two of dry sand on the top of the soil. Some forms of damping-off may be prevented by soil disinfection. See p. 95. Where damping-off has started, spraying the plants and ground with Bordeaux may do some good.

FROST AND COLD INJURY

With young citrus trees in frosty localities, wrap the trunks with corn or milo stalks in winter. Heap up earth around the butts. Enclose tender valuable young trees with burlap covers. For bearing groves obtain detailed information about methods and appliances for smudging with oil fuel. (See also Sour Sap.) Many plants are injured and disfigured by cold at critical stages of development, even when it is not cold enough to kill or even noticeably injure them at the time.

GRASSHOPPERS

Scatter poison bran mash or citrus bran mash freely (Formula 4 or 5). Be sure to mix the bran and poison thoroughly. Scatter in alfalfa fields about 4 o'clock in the afternoon and around orchard trees or other plants early in the morning.

GUMMOSIS

Gum formation in itself is not due to any one specific disease, but may be brought about by many different causes. In stone fruit and citrus trees gumming is simply a symptom of distress, which may be due to specific infections or various other causes, such as unsuitable soil, poor condition of soil, sunscald, excess or lack of water, frost, or attacks of parasites. Treatment must vary according to cause. Badly gummed branches may be removed, gummy diseased areas of bark cut out, and the wounds treated as in citrus gummosis. Splitting the bark is useless and often harmful.

NEMATODE (EEL WORM)

Microscopic worms of several species penetrate the tender tissues of plants. The garden nematode (*Heterodara radiculicola* Greef.) causes rounded irregular fleshy swellings or root knots on tender roots. If abundant, the roots may become much distorted and swollen, growth stops, and early rotting off follows.

Do not attempt to grow susceptible crops on infested soil. Keep such areas clean cultivated in summer or in a cereal crop. Grain may be grown in winter. Almost all important crops, except cereals and some fruit trees, are attacked by the garden nematode. The beet nematode (*H. schachtii* Schmidt) attacks some other plants, and where it occurs careful rotations should be followed with total exclusion of beets for many years. Alfalfa is not seriously affected by the common species, but carries it over to future crops. Alfalfa may be safely planted on beet nematode soil. Nematodes are worse on sandy soils.

Soil intended for greenhouse use should be taken from places where nematodes do not occur. The absence of nematodes is best determined by examining growing plants such as figs, peaches, melons, tomatoes, or nearly any soft-rooted vegetables. Where it is not possible to get soil which is certainly free, it should be sterilized. See p. 95.

Nematodes are frequently distributed in potatoes and rooted plants.

PHYSIOLOGICAL DISEASES

(Little Leaf, Exanthema, Die-Back, Mottled Leaf, Rosette, Bitter Pit, Dry Rot, Blossom-End Rot)

Diseases of a specific nature of which the cause is not known and of which the symptoms seem unlike the usual effects of unfavorable conditions or parasites. Most of these troubles show a relation to soil conditions and occur especially in dry, sandy, gravelly, or hardpan soils, those very deficient in humus, or under conditions of irregular soil moisture. Trees standing over old barnyards or corrals or where excessive amounts of manure have been applied are also likely to show some of these troubles. The most promising methods of treatment are increasing the humus content of the soil by means of green manure crops and mulches, breaking up all hardpan and plow-soles, more careful irrigation to insure the maintenance of a proper and uniform moisture condition of the soil down to a depth of several feet and throughout the season until rains occur, and planting alfalfa in orchards where plenty of water is available. The soil in areas where these troubles occur should be examined for alkali or other injurious substances. Where any of these diseases are serious and persistent it may be better to grow some other crop than to keep on with one which is seriously affected.

SLUGS AND SNAILS

May be controlled to some extent by thoroughly dusting finely powdered hydrated lime over the infested plants, but recent investigations have shown that a 5 per cent nicodust is very effective in killing these pests if applied late in the evening or on dull days when the animals are at work on the plants. Trapping by means of boards or wet sacks and killing those taking shelter thereunder is effective in a small way.

SOUR SAP, WINTER INJURY. Also see "Sunburn"

All the ordinary forms of sour sap are due to extreme variations in temperature. Differences in the effect upon individual trees or orchards are due to differences in condition and susceptibility of the trees, produced mostly by variation in the moisture condition of the soil. Do not force growth late in summer. Irrigate, if possible, about November 1, if no heavy rain has fallen. Whitewash bodies of trees early in November. Sour sap seems to be associated with hardpan

or periods of surplus water in the soil. Good drainage should be emphasized. A furrow may be opened in early winter on either side of the tree row to carry off surplus winter rains and prevent the soil from remaining saturated for prolonged winter periods. Numerous instances have been observed where open irrigation ditches have drained adjacent tree rows during the winter. Trees in the drained soil have escaped sour sap while those farther from the ditch in soil saturated with winter water have suffered badly.

Wood Decay Prevention, *Treatment of Pruning Cuts and Wounds.*

—It is doubtful whether any application on wounds materially assists healing except for some delicate plants like roses, where the cut stem may dry out. Treatment is to prevent infection with spores of wood decay fungi, which may be carried by wind, rain or otherwise, and be protected in cracks or rough places in dry wood or bark until moist weather, when they grow and penetrate the wood, causing rot. At some seasons bark knocked off may be renewed over the whole surface if undisturbed, or the bark may be replaced and held firmly and again grow on. Usually a wound must heal from the edges. The greatest danger comes from cracks in the heartwood, from rough breaks and from the "heel" at the bottom of a bad cut in which the bark nearly always dies back. Proper training of trees from the beginning to avoid narrow pinching joints and subsequent splitting is important. Treatment should be prompt, since when decay is established no disinfectant can be expected to penetrate far enough to destroy the active fungus in the wood. Make a clean cut, trimming the bark down smoothly to sound tissues around the edges. In the case of branches, make a close cut, leaving no projecting stub. Thoroughly cover the wound with Bordeaux paste (Formula 10), and when well dried cover with grade D asphaltum put on in a melted condition. Go over the work occasionally, especially in summer or early fall, and renew the application of asphaltum until the wound is entirely healed. Bordeaux mixture may retard the formation of callus. Some prefer to paint the whole wound at once with hot asphaltum. Others prefer to use the asphalt paint cold, but this should be done with care to keep cracks in the wood thoroughly covered. Some asphaltums, especially the cold paints, have caused injury. Where wounds have stood for some time before covering, it would be well to wet the dry wood with a solution of corrosive sublimate, 1 part in 500 parts of 50 per cent alcohol ($\frac{1}{4}$ ounce in 1 gallon). See p. 90 for precautions in using corrosive sublimate.

For tree surgery methods, send to Superintendent of Documents, Washington, D. C., for Farmers' Bulletin No. 1178, price 25 cents.

SUNBURN

Whitewash bodies in fall as well as spring. Shape the trees so that their trunks are shaded. Cut young trees back well before planting. Shade trunks with shakes or protectors. Do not allow trees to suffer from drought.

Tests show that the coloring matter in the bark of the trunk and exposed main limbs absorbs heat enough on sunny days in winter to raise the temperature of the growing layer 35° to 40° F. above the temperature of the air. As soon as the sun goes down the tree cools rapidly to atmospheric temperature, which may be freezing or below. Whitewash reflects the heat, so that the growing layer does not get warmer than the air; the cells remain dormant during the day, and are not injured by low temperatures at night. The above also applies in opposing sour sap.

TENT CATERPILLARS

Gray or brown, hairy caterpillars with row of white spots on back or pale bluish lines on sides, measuring from 1 to 3 inches long. They either live in compact colonies or in tightly woven webs or tents which are conspicuous on the trees. Entire colonies may be exterminated by cutting off or burning with a torch. Those on the trunks and large limbs may be killed by spraying with kerosene or concentrated oil emulsions. The small dark egg masses encircling the smaller limbs may be pruned out when the trees are dormant and burned. Spraying with arsenate of lead (Formula 1 or 2) will control the caterpillars effectually.

WIREWORMS

Wireworms get their name from their smooth, round bodies, which are usually shiny, varying in color from pale yellow to dark brown. The common injurious forms are about one inch long. They live in the soil, preferring sandy loams rather than heavy soils, although they may be found in either. The larval stages last from 1 to 3 years, so that to be effective control measures must cover the maximum period. The adult beetles are known as "click beetles" because of their ability to jump in the air with a clicking sound. They are mostly inconspicuous beetles of various shades of brown or entirely black, about one-half inch long. They are active and fly freely.

Control measures are difficult because of the underground habits of the larvae, and as yet have not been satisfactorily worked out for the different species. Clean culture and crop rotations are the most

reliable practices, while much good comes from thorough cultivation. Trapping the adults with small piles of straw and burning them in fall and winter destroys large numbers. Replanting is often necessary with many crops such as potatoes, beans, peas, melons, etc. Some control is claimed from scattering poison bran mash (Formula 4) over the surface of the ground.

HOUSEHOLD PESTS AND ANIMAL PARASITES

Ants.—Ants are not only serious household pests but do harm in the garden and orchard by distributing plant lice, scale insects, and other honeydew producing insects, and protecting them from parasitic enemies, which would otherwise destroy great numbers of these pests.

The ordinary small house ants, which give off a pungent characteristic “ant” odor when crushed, are best controlled by using various strong arsenic and syrup poisons sold as “ant poisons.” The Argentine ant, which gives off no characteristic odor, is controlled by a very weak arsenate and syrup poison which is carried to the young by the workers and which gradually kills out the whole colony. For this pest use Formula 7 or 8, or buy special Argentine ant poison.

Home-made containers for the latter poison may be made by punching small holes around the tight-fitting tops of cans and then dipping in hot paraffine to prevent rusting. A sponge is placed in the bottom and thoroughly wet with the poison, the lid is securely fastened, the container marked “Poison” and then hung up under or in the house, or in the gardens or orchards, away from the reach of children. Small fruit jars with holes punched in the lids may be used instead of cans, and if screwed very tightly are less likely to be opened by children.

Bed Bugs.—These insects lay their eggs in cracks and crevices about the furniture and room. They will withstand months of starvation. Heating the rooms infested to 120° F. for 12 to 24 hours is a satisfactory method of control where practical. Fumigation with cyanid is effective. Careful washing with corrosive sublimate 1-500 (1 ounce to 4 gallons of water) of all objects and crevices is a substitute if the other methods cannot be used. Care should be taken not to wet the hands or body in solutions of this strength. Live steam if available is effective when applied to bunks, crevices, etc.

Cockroaches.—Can best be controlled by mixing sodium fluorid (commercial) with flour in equal proportion and scattering it heavily along the shelves or corners frequented by the insects.

Clothes Moths.—These insects damage fur and woolen goods by the feeding of their larvae. Careful brushing and airing of stored materials at frequent intervals is the best protection for garments infrequently used. If stored over long periods, they should be carefully brushed, placed in tight boxes and the covers sealed with gummed paper. Fumigation with carbon bisulfid or carbon tetrachlorid is effective in heavily infested quarters. Moth balls, cedar chests, etc., are effective but will not kill larvae that are already present in the materials.

Fleas.—The presence of fleas is closely correlated with the presence of domestic animals or pets. They lay their eggs on these hosts. There hatches from these eggs which have dropped to the ground or floor, a maggot-like larva which lives on nitrogenous material until it changes into a mature flea. Domestic pets should be frequently dusted with fresh pyrethrum powder or washed in heavy suds of naphtha soap. Mats should be provided for pets to sleep on if permitted in the house and these regularly shaken over an open fire. All animals should be excluded from the basement. Floors should be mopped with “dry” mops moistened in kerosene. Naphthalene flakes spread over the floor of a room, allowed to remain for a few hours and then brushed into another room prove effective in severe outbreaks. For sticktight flea see Circ. 251.

Flies.—*Life History.*—The common house fly lays its eggs on freshly deposited manure heaped in piles, also on heat-producing piles of vegetables and animal matter. These hatch in about two days into tiny glistening white, footless maggots that grow rapidly for approximately a week until about half an inch in length, when they migrate from the moister part of the manure to a drier portion; here they turn into brown, barrel-shaped “pupae,” from which they emerge as full-grown flies in about four days.

The blow flies, flesh flies, buzz flies, or meat flies, as they are variously called, will also breed in manure and garbage, but prefer the bodies of dead animals left exposed on the ground or buried in shallow holes.

When garbage is fed to animals or left exposed, unless extra precautions are taken, fly breeding will occur in the garbage itself and even in moist soil that has become saturated with liquid food material, urine and feces.

Manure should be removed at intervals of less than one week and spread out in a layer sufficiently thin to cause immediate drying. If it must be kept on the premises for longer periods it should be stored in fly-tight bins or composted in neat, clean-edged piles.

Dead animals should be incinerated or if buried the carcasses should be liberally sprinkled with lime or crude oil and the ground well tamped.

Flies are best poisoned inside the house by sweetened 2 per cent solutions of formaldehyde mixed with milk and exposed in saucers at night ready for flies early in the morning, other sources of water having been removed.

The larvae may be destroyed in manure by sprinkling the pile with borax at the rate of $\frac{1}{2}$ pound to 10 cubic feet of manure and following this application with enough water to carry the borax at least six inches into the mass. Repeated borax treatment will make such manure injurious to plants if used as a fertilizer.

Mosquitoes.—These insects should be attacked in their breeding places, standing water, all accumulations of which should be drained or the depressions filled. If this is not practicable, oiling the surface with an oil made of equal parts of crude oil and kerosene will temporarily reduce the nuisance but must be repeated at intervals of two to three weeks. Inasmuch as certain mosquitoes are able to transmit malaria from one person to another care should be taken to prevent their entrance to living quarters by screening and individual capture if they succeed in gaining entrance. The malaria-transmitting species may be detected by their habit of standing with the head pointing down and the abdomen raised when at rest.

Silver Fish Moth.—This wingless leaden colored insect sometimes becomes important through its eating starchy materials such as laundered sheets, bookbindings, wall paper, etc. They are controlled by use of a bait composed of 10 parts of starch to 1 part of white arsenic.

Sow Bugs.—These crustaceans migrate indoors at the beginning of each rainy season. Damp cloths placed under a board at night outside the buildings or in basements collect large numbers which may be destroyed by soaking the cloth with hot water, kerosene or gasoline.

(See also Poison Baits, Formulas 4 and 5, p. 72.) Sliced potatoes or carrots sprinkled with Paris green or white arsenic often give good control if placed where the sow bugs are numerous.

Tule Bugs or Stink Bugs.—These bugs cause great annoyance by entering houses often in great numbers in search of shelter in the autumn time when they are driven by the rains from the lowlands where they breed and feed on other insects along the river margins and in moist places. Once in the house they are hard to get rid

of especially if the house is moist, but a well-warmed and dry house does not serve them well. Keeping doors and windows well screened and all cracks closed, particularly when lights are burning will help considerably in keeping them out when they are making their flights. The invasions are only temporary.

CATTLE

Ear Ticks—*Ornithodoros megnini* Duges—This tick lives its entire life within the auditory canals of the ears of domesticated animals, particularly cattle, except when it leaves to deposit its eggs in the ground. The young ticks hatching from these eggs crawl on the bodies of available animals and enter the ears. Control must be by individual treatment. The application of a half-and-half mixture of cottonseed oil and pine tar in quantity sufficient to fill the auditory canal is very effective.

Horn Flies *Haematobia serrata* R. D.—These flies, about one-half the size of the common house fly cluster about the rump and head of cows, sucking blood and constituting a serious nuisance in the case of dairy cattle. They deposit their eggs on the freshly deposited cow manure. The young maggots live in this material until ready to change to an adult fly, when they burrow into the surrounding earth to pupate. The life history lasts from 10 to 16 days.

Corrals should be cleaned of manure weekly or dragged with a heavy brush drag daily to break up the clots of manure and thus dry them out.

Biting Lice, *Trichodectes scalaris* Nitzsch.—The biting louse may be differentiated from the sucking louse by its round head and the fact that it is never found with its mouth parts imbedded in the animal's flesh. It may be controlled by one dusting with sodium fluoride (commercial) mixed with flour in even proportions, or by dipping, spraying, or bathing with a coal tar dip (Formula 26b) at intervals of ten days.

Sucking Lice.—These lice suck the blood of the animals and may be distinguished from the biting lice by their pointed heads and the fact that they are generally found with their mouth parts plunged into the animal's flesh. Sodium fluoride, so successful for the biting lice, is useless against this class of lice. Coal tar dips applied as a dip or spray or rubbed on are effective but must be repeated at the expiration of ten days to be successful. Raw linseed oil applied with a brush at intervals of a week will also control both types of lice.

Lungworms, *Dictyocaulus viviparus* Bloch.—These worms are parasitic in the air passages of the lungs. The eggs containing living young are coughed up and swallowed, hatch out in the small intestine, and, after spending a period outside the body are taken in again with food or water, and after penetrating the small intestine are borne back to the lungs. They cause serious damage by causing a collapse of those portions of the lung from which the air supply is shut off by the blocking of the bronchioles, thus forming a favorable medium for the growth of pathogenic organisms that may actually cause the death of the infected animals. Chloroform injected into the nostrils in quantities sufficient to make the animals slightly groggy, often kills large numbers of the lungworms and greatly facilitates recovery. (See "Sheep" regarding the danger of chloroform treatment with this animal.) Sufficient food and proper shelter are very important. Infection is incurred in moist, swampy localities. Wherever possible such areas should be eliminated from the range or fenced off and drinking water supplied in troughs high enough to avoid contamination with feces.

Ticks.—Various ticks attack the bodies of cattle. Where these occur in large numbers or where the tick concerned is the Texas Fever Tick, *Margaropus annulatus* Say, which may be recognized by its chestnut-colored shield and the fact that its first pair of legs originates on the "shoulders" and not close to the shield, measures should be taken for control. Dipping in an arsenical dip (Formula 3a) is most satisfactory. Where only a few animals are concerned, spraying may be substituted for the dipping.

Warbles, *Hypoderma lineata* de Villers.—These maggots which cause the lumps or swellings on the backs of cattle are the larvae of a fly resembling a bee which deposits its eggs on the heels or legs of cattle. On hatching these maggots bore into the skin and penetrate to their position on the back beneath the skin. When about ready to change to a fly a hole appears above the maggot which is used for its exit. It then falls to the ground, burrows into the earth for two or three inches whence it emerges in about three weeks as a full-grown fly ready to deposit eggs on other cattle. The control is individual in that the maggot when "ripe" must be forced out of the lumps on the back and *destroyed*. Care should be taken not to crush the warble in the wound for such accidents sometimes produce serious poisoning. If this happens the wound should be carefully washed out with water to which salt at the rate of two teaspoonfuls to the pint has been added.

SHEEP

Head Maggot, *Oestrus ovis* Linn.—These pests are the larvae of flies that deposit their eggs on living young near the nostrils. The young migrate up the nasal cavity penetrating to the sinuses where they are often trapped by their growth in size. Their presence may be detected by the attitude of the infected animal, which stands head down and inclined to one side and at intervals follows the inclination of its head around in circles. This may be distinguished from “gid” by the fact that with head maggot infestations there is a discharge from the nostrils. Some relief may be had by causing the animals to sniff up red pepper, the larvae being discharged by violent sneezing. Prevention is accomplished by the use of “salt logs” made by boring 2 to 3 inch holes in a log, filling the cavities with salt and smearing the circumference of the holes with soft tar. The animals in attempting to get the salt keep their muzzles painted with tar which acts as a repellent.

Lungworms, *Dictyocaulus filaria* Rud.—See “Cattle” for general consideration. Little can be done in the way of treatment for sheep affected with lungworms as they are very susceptible to chloroform, which consequently cannot be used for these animals. Good food and comfortable shelter will generally accomplish the desired end although the sanitary precautions should not be overlooked.

Scab.—This disease which manifests its presence by the “tagging” of the wool and crusting of the underlying skin is caused by a microscopic mite, *Psoroptes communis* var. *ovis*. Hering. These mites puncture the skin causing an intense itching; the roughening of the skin and eventually a crustiness causes the wool to fall out or “tag.” Control is by means of dipping in lime-sulfur dip (Formula 17a). Pastures which have been used for infested sheep should not be utilized for clean sheep for three months unless drenching rains have intervened.

Wool Maggots.—These pests are the larvae of flesh flies that, attracted by the odor of soiled wool, attack first the wool and later the flesh of the sheep. The points of attack are largely confined to the area about the hind quarters where the wool becomes soiled with feces. “Crutching,” the clipping of the wool around the anus and inside the hind legs, helps prevent infestation. Infested flesh should be cleaned of maggots by the application of sheep dip and the odor of putrefaction destroyed by formaldehyde or pine tar in order to prevent further infestation. “Jetting” of the hind quarters under 100 pounds pressure with sheep dip to which 5 pounds of white

arsenic has been added is curative and acts as a protection for from one to three months. The bodies of dead animals, in which these flies also develop in enormous numbers, should be incinerated.

DOGS

Fleas.—See “Household Insects.”

Mange or Scabies.—See “Sheep” for general consideration. *Sarcoptes scabiei* var. *canis* Linn. Treatment.—Affected parts should be thoroughly washed with warm water and soap until the skin is thoroughly softened. Sulfur ointment made by mixing sulfur and lard should be carefully rubbed into the skin. This should be repeated every five days.

Demodectic or Follicular Mange is commonly called the “Red Mange” of dogs. It is caused by a microscopic elongated mite known as *Demodex folliculorum* Simon which burrows into the hair follicles. The chances of cure are slight and valuable or valued dogs should be placed under the care of a skilled veterinarian where facilities are available for the production of auto-vaccines. Itchthyol (10 per cent) and formalin (5 per cent) are both highly recommended.

Roundworms, *Toxascaris limbata* R. & H. and *Belascaris marginata* Rud.—These worms normally inhabit the small intestine but are great wanderers and are often found in the stomach which accounts for their name of “maw” worms. The eggs are ingested with food contaminated by the feces of infested dogs. These hatch in the stomach and the larvae penetrate to the lungs, into the air spaces of the latter, up the windpipe and down the esophagus to their final resting place in the small intestine. This migration is often the cause of serious pneumonic difficulties in puppies.

Control is by administration of oil of chenopodium at the rate of 1 c.c. for each pound of body weight combined with a dose of castor oil.

Tapeworms.—All tapeworms of the dog have an intermediary host, i.e. another animal in which the tapeworm lives and which must be eaten by the dog in order to infect the latter. The various tapeworms of dogs find their intermediary hosts in lice, fleas, rabbits, and sheep among others. The commonest tapeworm of dogs is *Dipylidium caninum* Linn., the double pored tapeworm.

Biting lice or larval fleas become infected with the larval stage of this parasite by eating particles of the dogs feces containing the “eggs” of this worm. The young form develops in the louse or flea and when these are eaten by the dog the larval tapeworm avoids

digestion, attaches itself to the lining of the intestine and becomes a mature tapeworm. The most efficient treatment is arecoline hydrobromide in $\frac{1}{8}$ - to $\frac{1}{4}$ -grain doses placed on the tongue of the animal. With valuable dogs or toy dogs this treatment should be administered by a veterinarian who would be able to recognize symptoms of poisoning and apply the necessary antidotes. No preparation is necessary and the tapeworms are generally eliminated in from ten to fifteen minutes.

SWINE

Lice, *Haematopinus suis* Linn.—The control of the sucking lice of hogs is extremely important. The irritation together with the loss of blood occasioned by their attacks is the cause of considerable losses when taken in the aggregate. Crude oil is the best remedy. This may be applied by soaking it on burlap-wound posts in the corrals against which the hogs will rub, or by applying it to the surface of their wallows if the latter are located in the shade.

Scabies or Mange, Common, see “Sheep.”— *Demodectic*, see “Dogs.”

The control of demodectic mange on hogs is seldom of economic importance, as the disease affects only the skin and is seldom serious during the relatively short life of the breeding stock. The same measures may be taken as for dogs. The snout and face about the eyes are the parts generally affected.

Roundworms, *Ascaris lumbricoides* Linn.—For life history see “Dogs.”

Treatment—Starve the infested animals for twenty-four hours. Administer individually 4 c.c. of oil of chenopodium and 1 ounce of castor oil to each hog of less than 100 pounds and twice the dose for those over this weight.

GROUND SQUIRRELS

The five most effective methods of destroying ground squirrels are: (1) poisoning with strychnine; (2) fumigation with carbon bisulphid (3) trapping; (4) shooting; (5) encouragement of the natural enemies of the ground squirrel. (See Circ. 181.)

1. Carbon bisulphid is most effective when the soil is damp. When the ground is dry the gas escapes through the cracks in the ground.

2. Strychnine-coated barley is best used during the dry season because at this time the squirrels gather and store grain and hence are easily poisoned through their cheek pouches when in the act of carrying the poisoned grain. Rain and heavy fogs tend to wash the strychnine off the poisoned grain.

3. Trapping and shooting are effective at any time, but are from six to twelve times more so before the young are out, before April 1, than later in the season.

4. Powdered strychnine (sulfate) in fresh vegetables and fruit is especially effective in the dry season when green food is scarce. (Formula 33.)

5. Red-tailed hawks, Golden eagles, badgers, weasels, and other natural enemies of the ground squirrel will prove valuable allies in the war on ground squirrels if they are only allowed to live. It costs little to let them alone to go about their business in the natural way.

GOPHERS

The five most effective methods of destroying gophers are: (1) poisoning with strychnine; (2) trapping; (3) flooding; (4) fumigation with carbon bisulphid; (5) for permanent relief, the encouragement and protection of the gopher's natural enemies, especially the barn owl and the gopher snake.

The solution of the gopher problem lies in a combination of two or more of the above methods, rather than in any one of them. Where a large acreage is to be treated, poisoning with strychnine (Formula 34) will be found most effective in reducing the pest. Traps are *safe*, can be used at any time, and are effective in the hands of a man who is not afraid to dig and who uses care in setting and placing them. Trapping is especially adapted to pastures, where there might be danger of poisoning stock, and to gardens, orchards, and the banks of irrigation ditches. Carbon bisulphid should be used only when the ground is wet. Both traps and carbon bisulphid are good "follow-up" methods in getting the gophers which refuse to take poisoned bait. Land that can be successfully flooded, so as to drown out the gophers, has usually been graded for irrigation crops such as alfalfa. Flooding (irrigation) is therefore automatic, and it is comparatively easy to hunt and kill gophers which are being flooded out. A man that kills all gopher snakes and barn owls on his place will have to fight gophers, and deservedly so. (See Bull. No. 340.)

RABBITS

If very abundant, must be fenced out of young orchards and gardens to avoid serious damage. Shooting and poisoning are the principal means of destruction. An application of whitewash containing bitter aloes to the trunks of young trees is sometimes recommended, but this has not shown much value in actual practice.

Soaked, chopped alfalfa sprinkled with strychnine, Paris green or white arsenic is very effective in destroying cotton-tails.

RATS

These pests should be handled by trapping if possible. Spring traps should be used, baited with fried bacon and the entire trap flamed with a burning newspaper before setting. When traps fail, a poison bait made by mixing barium carbonate with bananas, hamburger steak, or moistened bran mash in the proportion of 1 part of poison to 4 parts of the carrier may be used.

VENOMOUS INSECTS, SPIDERS, ETC.

Among the few venomous insects, spiders, etc., the most noteworthy are the so-called kissing bugs (cone noses), hour glass or shoe button spider, the pajaroello tick and the scorpion. Two species of kissing bugs (*Triatoma protracta* Uhler, a black species, also known as the China bed bug or cross bug, and *Rasahus thoracicus* Stal, the two-spotted corsair, a reddish-brown species with a large brick red spot on each wing cover) inflict particularly painful bites which in turn may result in more or less severe symptoms such as vomiting and rash.

These insects usually bite at night, but may also do so when disturbed during the day. Bathing the wound immediately with a 1 to 1000 solution of mercuric chloride (poison) or strong ammonia will afford some relief. The same treatment may be applied for the stinging of scorpions.

The bite of the shoe button spider (*Latrodectes mactans* Fabr.) and that of the pajaroello tick (*Ornithodoros coriaceus* Koch) may prove serious, and a physician should be consulted. The immediate application of potassium permanganate is recommended.

FORMULAS AND DESCRIPTIONS OF MATERIAL*

ARSENICALS

Acid Lead Arsenate (Lead Hydrogen Arsenate, Di-lead Arsenate, Often Labeled "Standard" or Lead Arsenate).—The acid type of lead arsenate contains more poison per pound than the basic type, is a stronger poison and acts more quickly. It is, however, somewhat susceptible to the action of other chemicals, particularly those of an alkaline nature (such as soaps, lime-sulfur solution, etc.), and is more or less dissolved by them when used as a combination spray. In moist climates along the coast, or in continuous damp, cloudy weather elsewhere, whether used alone or in combination with other sprays, some of the arsenic is apt to be dissolved and to cause serious foliage injury. It is not considered a safe arsenical for use on stone fruits, beans, or other susceptible plants.

Basic Lead Arsenate (Usually Labeled "Tri-plumbic" or "Neutral").—The basic type of lead arsenate is a weaker poison and acts more slowly. It is not decomposed, however, by chemicals of an alkaline nature, such as are usually applied with it as a combination spray, nor by the damp weather of the coast regions. It is considered the only safe arsenical to use on stone fruits, beans, or other susceptible plants.

The lead arsenates are usually sold as a paste containing about 50 per cent of water, or as a dry powder. The paste should be thinned somewhat with water and worked into a smooth cream before adding to the spray tank. The powder may be added directly to the tank and mixed by means of the agitator.

For codling moth and most defoliating insects use:

FORMULA 1

Dry acid lead arsenate (paste, 4 to 8 pounds)	2 to 4 pounds
Water	100 gallons

Or

FORMULA 2

Dry basic lead arsenate (paste, 5 to 10 pounds)	2½ to 5 pounds
Water	100 gallons

Dry or powdered lead arsenate contains twice as much arsenic as the paste; therefore use only one-half as much of it.

* Mr. Geo. P. Gray furnished much of the information relative to the chemical compositions and reactions of these insecticides.

Zinc Arsenite is a stronger and more active poison than either type of lead arsenate, and is useful in controlling the various caterpillars which are troublesome on pears and apples in the early spring, but is very apt to cause injury if the application is made after the time of full bloom.

FORMULA 3

Zinc arsenite powder	3 pounds
Water	100 gallons

White arsenic (Arsenic trioxide) is only sparingly soluble in water, although sufficiently so to prohibit its use on plants as an insecticide. Its use as a stomach poison is therefore limited to the preparation of poison baits for the control of grasshoppers, army-worms, cutworms, etc., and to some other cases where the insecticide is not to be applied to growing plants.

FORMULA 3a

Government Arsenical Dip.

Caustic soda	4 pounds
White arsenic	8 pounds
Sal soda crystals	8 pounds
Pine tar	1 gallon
Water to make	500 gallons

Dissolve the caustic soda in an iron vessel (zinc, tin or solder will be corroded) using 1 gallon of water. Then add the arsenic slowly, with constant stirring. The temperature of the solution while mixing should be just below boiling. Add the sal soda after the arsenic is dissolved, stir, then make up to 5 gallons.

Emulsify the pine tar by dissolving $\frac{3}{4}$ of a pound of caustic soda or concentrated lye in 1 quart of water and adding to this 1 gallon of pine tar. Stir until a clear molasses-like liquid results. If a drop of this does not mix perfectly with water, stir in caustic soda until a perfect mixture of tar and water results.

To prepare the dip, dilute the emulsified tar with two or three times its volume of water and pour this into the dipping tank, after the latter is three-fourths full. Add the arsenical solution in the same way and make up to the desired amount.

This solution is very poisonous and should be handled and disposed of with great care.

Poison Bran Mash.

FORMULA 4

Bran	25 pounds
White arsenic	1 pound
Molasses (cheap blackstrap preferred)	2 quarts

Mix the arsenic and the bran dry and add the molasses which has been diluted with water. Add enough water and mix thoroughly to make a dry mash which will broadcast easily.

Citrus Bran Mash.

FORMULA 5

White arsenic	1 pound
Molasses (cheap blackstrap preferred)	2 quarts
Lemons (or oranges)	6 fruits
Water (about)	4 gallons
Bran	25 pounds

Mix the above materials as follows: Stir thoroughly the white arsenic, molasses, and water first. Grind the lemons, including the rinds, in a meat grinder, or chop fine, and add to this liquid. Then slowly pour this over the bran and stir thoroughly until an even mixture is secured.

The amount of water to use in the preparation of these baits will vary according to the coarseness of the bran or substitutes. A barely moist mash is preferable to a wet one because it does not harden under the heat of the sun and remains palatable, while wet mash becomes baked and unattractive.

Substitutes in Poison Baits.—Paris green may be substituted for white arsenic in Formulas 4 and 5. Alfalfa meal, shorts, or rice meal have been successfully used as a substitute for bran in the preparation of the above formulas.

Sodium Arsenite.—This arsenical is readily soluble in water and is one of the most violent of the plant poisons. It probably acts more quickly than any of the better-known arsenical poisons, and is commonly used in the preparation of weed killers, poison fly-papers, cattle dips for the control of ticks, ant syrups, and to some extent in the preparation of poison baits.

Sodium arsenite may be purchased ready made as a white powder, but it is not always readily obtained at pharmacies, nor can it always be depended upon to contain a uniform amount of arsenic. This chemical may be easily prepared from white arsenic by combining the latter in the presence of water with sal soda, soda ash, caustic soda, or a good grade of concentrated lye in the following proportions:

Sal soda or washing soda, 2 parts to 1 part of white arsenic.

Soda ash, 1 part to 1 part of white arsenic.

Caustic soda, 1 part to 2 parts of white arsenic.

Concentrated lye, 1 part to 2 parts of white arsenic.

If sal soda or soda ash is used it is necessary to boil the mixture fifteen or twenty minutes before the arsenic is dissolved. If caustic soda or concentrated lye is used, little or no heat is necessary. In either case, a corrosive chemical known as sodium arsenite is formed.

A soluble arsenical can be made by using 1 part of caustic soda to 4 parts of white arsenic (arsenic AS_2O_3) trioxide, such a solution, however, has a tendency to form crystals on standing.

Sodium Arsenite.

FORMULA 6

Sal soda	2 ounces (or 2 pounds)
White arsenic	1 ounce (or 1 pound)
Water (about)	$\frac{1}{2}$ pint (or 1 gallon)

Put all the ingredients together in an iron or graniteware kettle (do not use aluminum) of sufficient size to allow for considerable frothing, and boil fifteen or twenty minutes, or until the solution is clear.

Ant Syrups.

FORMULA 7

	Strong for native ants	Weak for Argentine ants Large quantity	Small quantity
White arsenic	2 oz.	1 oz.	1 scruple
Concentrated lye	1 oz.	1 oz.	$\frac{1}{2}$ teaspoonful
Sugar	1 lb.	20 lbs.	1 lb.
Water	1 pt.	3 gals.	1 pt.

The U. S. Bureau of Entomology recommends a later formula for the preparation of Argentine ant syrup which is said to be superior to any other formula tested by them, "on account of its stability at high temperatures, freedom from crystalization, and continued attractiveness."

Government Argentine Ant Syrup.**FORMULA 8**

Granulated sugar	12 pounds
Water	11 pints
Tartaric acid (crystalized)	7 grams
Benzoate of soda	9 grams
Boil slowly for 30 minutes. Allow to cool.	
Dissolve sodium arsenite (C. P.)	$\frac{3}{4}$ ounce
In hot water	$\frac{1}{2}$ pint
Cool. Add poison solution to syrup and stir well.	
Add to the poisoned syrup:	
Honey, strained	2 pounds
Mix thoroughly.	

COPPER COMPOUNDS**Bordeaux Mixture (Average Strength).****FORMULA 9**

Bluestone	16 pounds
Quicklime	20 pounds
Water	200 gallons

Dissolve the bluestone and slake the lime in separate vats, the bluestone to be kept from contact with all metals except copper. Thoroughly mix the dissolved bluestone with one-half the water and the slaked lime with the other half. Run the two mixtures together in a single stream into the spray tank through a fine screen. For convenience, the mixing vats may be placed on an elevated platform, and the two parts mixed as they are flowing into the spray tank. The milk of lime should be continuously stirred during the mixing.

A somewhat less satisfactory Bordeaux mixture may be made as follows: Slake the lime and dissolve the bluestone in separate barrels as above. Fill the spray tank half full of water; add the dissolved bluestone; strain in the slaked lime while the agitator is running; add remainder of water, and mix thoroughly.

Bordeaux Paste.**FORMULA 10**

A. Bluestone	12 pounds
Water	8 gallons
B. Quicklime	24 pounds
Water	8 gallons

Dissolve the bluestone and slake the lime separately in the amounts of water specified. Then mix together equal quantities of each ingredient, making up only enough for each day's use.

Commercial Bordeaux Mixture.—Several preparations of this sort are on the market in the form of a paste or dry powder to be diluted with water. Objection is sometimes made to these preparations that they will not remain in suspension in water as well as the home-made Bordeaux mixture, but some of them are probably as good or better than the average mixture prepared on the ranch. The commercial preparations are more expensive, but also more convenient for use, and are of especial value to the small grower.

Resin-Bordeaux Mixture.

FORMULA 10a

Bluestone	20 pounds
Lime	26 pounds
Resin	10 pounds
Soap (soft)	16 pounds
Water	200 gallons

Melt the resin in an iron pot; then add the soft soap, heat and stir until well mixed and quite soft. Add hot water and boil and stir for some time until thoroughly dissolved. Add this to the Bordeaux which has been made in the usual way. (From Univ. Calif. Exp. Sta. Bull. 165, p. 77.) This is for use on plants with very smooth waxy surfaces on which fungicides do not spread and adhere well.

Bluestone (Copper Sulfate).—A soluble compound of copper, the raw material for the preparation of most other compounds of copper. This cannot be used on foliage.

For dipping grain use:

FORMULA 11

Bluestone	1 pound
Water	5 gallons

Dip for 3 minutes.

Followed by:

Quicklime	1 pound
Slaked in water	10 gallons

For lemon wash water use:

FORMULA 12

Bluestone	1½ pounds
Water	1000 gallons

Copper Carbonate.—For dust treatment of grain, use Formula 11a. For dusting wheat for bunt, use 2 ounces of copper carbonate dust to a bushel. The dust should be intimately mixed to thoroughly

cover each seed. The copper carbonate dust should contain 50 per cent of copper in the form of carbonate and hydrate of copper, and should be sufficiently fine to weigh approximately 32 pounds to a cubic foot. The dusted seed may be stored without injury from the dust.

Ammoniacal solution of copper carbonate.—This solution contains no sediment and on drying leaves no unsightly marks. It may therefore be used when the spotting that the Bordeaux mixture causes precludes the use of that fungicide. The mixture consists of a solution made by dissolving copper carbonate in ammonia-water in the following proportions:

Copper carbonate	6 oz.
Ammonia, about	3 pints
Water	50 gals.

Weigh out the proper amount of copper carbonate. Set a very small portion of this aside and dissolve the remainder of it in diluted ammonia (dilute ammonia with water to about 5 times its volume), using only enough ammonia to dissolve it. Then add the portion of copper carbonate which was reserved. This will insure the use of no more ammonia than is necessary. It is better to have a little too much of the carbonate in the solution than to have too much ammonia. The strong solution made in this way may be diluted with the proper amount of water. The copper carbonate may be purchased directly from the drug store, or it may be prepared at home.

SULFUR AND SULFUR COMPOUNDS

Dry Sulfur.—For dusting upon plants for the control of surface mildew, red spider, or other parasites, the fineness of the sulfur is an all-important consideration. Flowers of sulfur, the finest and fluffiest grade of sublimed sulfur, has been heretofore recommended for application as a dust, but at present there are upon the market several brands of extremely finely ground sulfurs, which are as fine as some of the best grades of sublimed sulfur and no more expensive. Some of these sulfurs, which have been specially prepared for dusting, are ground to pass a 200-mesh bolting cloth. These are apt to cake and to clog the dusting apparatus. If 9 parts of sulfur are thoroughly mixed with 1 part of hydrated lime, kaolin, or other inert powder, these difficulties may be avoided.

Sulfur Pastes or Wettable Sulfurs.—For various reasons it is often desirable to mix sulfur and water and apply it to plants as a spray. Sulfur, however, is not easily wetted with water and it is a difficult matter to make a uniform mixture of the two. It has been found that a number of substances—soap, calcium caseinate, oleic acid, glue, diatomaceous earth, flour, dextrin, etc.—when mixed with water and sulfur have the property of counteracting the mutual repulsion of sulfur and water without otherwise altering the nature of the sulfur. Certain of these substances have been used in the preparation of commercial sulfur pastes or wettable sulfurs. These commercial pastes, as now manufactured, contain from 45 to 50 or more per cent of sulfur in a very finely divided condition, the remainder being water and one of the substances mentioned above. The effect of these pastes is that of dry sulfur. The usual strength to use is:

FORMULA 13

Commercial sulfur paste	8 to 21 pounds
Water	100 gallons

Home-Made Wettable Sulfur.—A satisfactory wettable sulfur can be easily made at home by the use of glue water as follows:

FORMULA 14

Powdered glue	$\frac{3}{4}$ ounce
Hot water	$1\frac{1}{2}$ gallons
Sulfur (flowers or powdered)	5 pounds
Water to make	100 gallons

Dissolve the glue in hot water or soak over night in $1\frac{1}{2}$ gallons of cold water. Add the glue water to the sulfur a little at a time and work up into a smooth paste as free from lumps as possible. Rubbing is better than stirring. Wash this paste into the spray tank through a fine screen, using the remainder of the glue water to wash it through and a stiff brush to break up the remainder of the lumps. Then add plain water to make 100 gallons.

Another formula more expensive than the above is:

FORMULA 15

Make a paste of:

Flour	4 pounds
Water	4 gallons

Mix this with:

Sulfur (sublimed or powdered)	5 pounds
Then add:	
Water to make	100 gallons

FORMULA 15A

Self-Boiled Lime-Sulfur Wash.—A preparation of sulfur largely used in the eastern states for a summer spray on peach and other tender foliage and comparable in use with the wettable sulphur preparations.

Quicklime	32 pounds
Sulfur	32 pounds
Water to make	200 gallons

Put the quicklime in a suitable container and add water to start slaking, about 12 gallons (hot water for sluggish lime and cold for active.) Work the sulfur through a sieve and add to the lime with stirring to prevent caking. Add enough water to make a paste. When the violent boiling ceases, add cold water to make up to the final amount. If allowed to stand hot, the mixture becomes caustic. The wash must be strained and applied with a pump having a good agitator.

The usual grades of sublimed or powdered sulfur may be wetted in the manner described in Formulas 14 and 15, but for the best results the finest grade of sulfur obtainable should be used. The sulfurs especially prepared for dusting are recommended for this purpose.

Lime-Sulfur Solution.—This is the most active form in which sulfur compounds are commonly used in the control of insects or fungi. Its causticity prohibits its use on any foliage except that of the more hardy plants, and then in a very dilute form. Its principal use is as a dormant spray for the control of certain fungus diseases, scale insects, red spider, and a variety of other pests of deciduous trees.

Commercial Lime-Sulfur Solution.—The horticulturists of the state are being supplied with concentrated commercial lime-sulfur solution of good quality and at reasonable prices. The great bulk of this important pest remedy used in the state is therefore of commercial manufacture, testing between 32° and 34° Baumé. It is only necessary to dilute this with water before spraying.

Home-Made Lime-Sulfur Solution.

FORMULA 17

Stone lime	50 pounds
Sulfur (sublimed or powdered)	100 pounds
Water to make	50 gallons

Heat about one-third of the total volume of water required. When the water is hot add all of the lime, and then immediately all the sulfur, which should previously have been made into a thick paste with water. After the lime is slaked another third of the water should be added, preferably hot, and the cooking should be continued until a clear orange-colored solution is obtained (usually 45 to 60 minutes), when the remainder of the water should be added, either hot or cold, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in a kettle. After the wash has been prepared it must be allowed to settle and then strained through a fine sieve as it is being run into the spray tank. The resultant product is a concentrated solution of lime-sulfur, which should be diluted about six times with water for a winter spray.

Dry Lime-Sulfur.

Lime-sulfur is now obtainable in the form of a dry powder which is used by dissolving in water. 40 pounds to 200 gallons of spray is usually recommended for application on dormant trees. A strength of about 10 pounds to 200 gallons is generally recommended for use on foliage as in treating apple scab, red spiders, etc.

The recommendations for the dry lime-sulfur sprays call for the use of a smaller amount of total sulfur in general than is used with the liquid lime-sulfur solution, but the comparative efficiency of the preparations seems not to be fully determined.

FORMULA 17a

Lime-Sulfur Dip.

Lime (unslaked)	8 pounds
(or 11 pounds of commercial hydrated lime)	
Flowers of sulfur	24 pounds
Water	100 gallons

Slake the lime, sift in the sulfur and make a thin paste; add water to make 30 gallons, and boil for one hour, stirring during the process. Add water while cooking to maintain the original amount of 30 gallons. Strain or siphon off the liquid and make up to 100 gallons. An excess of lime or sediment in the dip will injure the sheep and wool.

The standard lime-sulfur dip as made above may be combined with one-half standard arsenical dip (see Formula 3a) for sheep "ticks."

Alkali Sulfides.—Sulfides of soda ("soluble sulfur") are sometimes used in place of lime-sulfur solution and have some advantages over the liquid preparations.

PDB or PARA-DICHLOROBENZENE, A NEW SOIL FUMIGANT

The use of para-dichlorobenzene as a soil fumigant to control soil infesting insects has created a large interest in California. The experiments conducted during the past two years, while not extensive, will be of interest in outlining a larger practice for next season.

The material in question is a white crystalline substance which is insoluble in water and evaporates slowly at a temperature of 55° to 75° F. and more rapidly at higher temperatures. The vapor is more than five times heavier than air and more than twice as heavy as carbon bisulfide vapor. It possesses a weak ether-like odor which is practically nonpoisonous and noncombustible.

Common name of material.—Para-dichlorobenzene has such a long name that it seems advisable to abbreviate it by using P. D. B. for short. Various trade names such as "Paracide," "Crystal Glass," etc., are already appearing, and many others will soon follow.

Conditions of application.—In applying the material two things are important; soil moisture and temperature. Because gases do not readily circulate in a thoroughly wet soil it is useless to apply para-dichlorobenzene unless the soil is not more than ordinarily moist, as is usually the case in California during the summer and fall except just after irrigations. In such cases a week or two following the application of water would be preferable. The soil temperature should range from 75° to 85° F. for the best results, for under such conditions the para-dichlorobenzene volatilizes more rapidly and the insects are more active, requiring a greater air supply, and are consequently more readily killed by the vapor.

Time of application.—In California the period from the first of May until November may be roughly designated as the proper time to make the applications, provided the soil temperature is over 55° F. and the soil moisture is not excessive.

Methods of application.—From $\frac{3}{4}$ to 1 ounce of para-dichlorobenzene is sufficient to treat an average size tree. First, level the surface of the soil around the base of the tree; then sprinkle the material around the tree in a continuous band or circle two inches wide with the inner margin two to four inches from the bark of the tree. Cover the material with soil around the base of the tree to a depth of from two to four inches and pack well with several strokes of the shovel.

Kinds of trees to treat.—Under eastern conditions, where the use of this insecticide has been quite extensive, it has been applied chiefly to peach trees on peach root-stocks. The eastern investigators caution against using it on trees under six years of age, although younger trees are reported to have been treated with no injurious results in many instances.

In California apricot trees on Myrobalan rootstock and infested with the peach tree borer have been treated with good results in killing the borers without injury to the trees.

Even nursery stock on Myrobalan and peach roots treated in the early summer showed no ill effects, but such work should receive more attention before general recommendations can be made.

California conditions are so different from those in the southern and eastern states that it is to be expected that we shall encounter many unusual problems in the handling of the material and that its uses may be very greatly enlarged. The Division of Entomology and Parasitology is contemplating a large series of orchard demonstrations and experiments during the coming year in order to have as much local information as it is possible to accumulate in that time.

Not for flat-headed borers.—Para-dichlorobenzene is being recommended by some insecticide dealers for all woodboring insects, particularly for the flat-headed apple tree borer. This insect and the other wood borers which work above ground cannot be satisfactorily reached by the fumes of the fumigant and *cannot be controlled by it!*

CRUDE PETROLEUM

The use of crude petroleum is almost entirely limited to the winter spraying of deciduous trees when the buds are entirely dormant. It is generally applied from November to February. The crude oil emulsion is especially recommended for black scale (*Saissetia oleae*), European fruit Lecanium (*Lecanium corni*), European or Italian pear scale (*Epididiaspis piricola*), cherry scale (*Lecanium cerasorum*), and other scales infesting deciduous fruit trees. It is practically the only spray treatment which has been effective against European or Italian pear scale, and will destroy the winter eggs of many of the aphids, of the red spider, and of some of the defoliating caterpillars.

When crude oil is thoroughly applied it sometimes penetrates the fruit buds to a considerable extent, and may injure and even kill some of them. The great majority of the buds are not injured, however, but appear to be stimulated to a more vigorous growth, and to the

production of foliage resistant to disease. It is good practice, especially in dry seasons, not to apply crude oil emulsion until there is indication of swelling of the buds.

A natural crude petroleum, testing about 23° Baumé, is preferred, as it contains some of the lighter and more penetrating oils. Heavier crude oils have given satisfactory results, even those testing 18° and even lower. Residuum oils (the residue of crude petroleum after the lighter portions have been distilled off) can be used if natural crude oil is unobtainable, provided their content of asphaltum is not too high to prevent their emulsification.

Crude Oil Emulsion.

FORMULA 18

Water to make	200 gallons
Liquid soap	3 gallons
Natural crude petroleum (21°–24° Baumé)	25 gallons

Partly fill the spray tank with water, add the liquid soap, agitate thoroughly for one minute, add crude oil and continue the agitation while running in the remainder of the water. If liquid soap cannot be obtained, use 20 pounds of fish oil soap dissolved in 10 gallons of boiling water to which 3 pounds of caustic soda or lye have been added. To kill moss or lichens on fruit trees, add 2 pounds of caustic soda or lye to the formula.

During the spraying operation this emulsion should be thoroughly agitated and great care taken to wet all of the twigs. From 8 to 10 gallons should be used on a tree.

PETROLEUM DISTILLATES

Kerosene, of about 40° Baumé, applied in the form of an emulsion, has been used to a considerable extent as an insecticide, particularly on citrus trees. The cheaper, unrefined distillates have now largely replaced kerosene as a foliage spray. These are more effective as insecticides, so that smaller percentages may be used in the emulsions, but coupled with their superior insecticidal properties is their greater toxicity to fruit and foliage. The toxicity varies with climatic conditions, foliage injury being most certain in dry weather with a temperature of 95° F. or more. Unfortunately, the season when spraying is most effective against scale insects on citrus trees is often during the hottest and driest months. It seems impossible to guarantee immunity from damage under all conditions with any of the distillates obtainable.

Little injury to citrus fruit and foliage occurs in the coast regions where distillate emulsions have been used, but in the interior sections the use of this insecticide is very hazardous.

Spraying with distillates, or with any other material, is not recommended as a substitute for fumigation in commercial citrus orchards, except in the case of young orchards, trees about dooryards, or where fumigation may not be convenient, or infestation may be light or limited to occasional trees. In such cases, Formula 19 is considered the most satisfactory.

Kerosene emulsion is the safest of the petroleum-distillate sprays, although the most expensive. The "W. W." or "Water White" is a trade name of a low-grade kerosene and is safer than the usual grade of material sold as "distillate." The highly refined "case goods" kerosene has been found to cause the least amount of injury of any of the petroleum derivatives, but its cost is prohibitive except on a small scale. If much of the kerosene emulsion is allowed to run down the trunks of young trees, injury is likely to occur just beneath the surface of the ground.

The following formula is intended for use on citrus trees:

Kerosene Emulsion.

FORMULA 19

Kerosene	15 gallons
Liquid soap	$\frac{3}{4}$ gallon
(Or hard soap	4 to 12 pounds)
Water to make	200 gallons

If liquid soap is available, it is preferable to hard soap, since it requires no heating. Hard soap, preferably fish oil soap, is cut in thin slices and dissolved in hot water. The soap is placed directly in the spray tank with 10 or 15 gallons of water or more (the exact amount is not important) and the engine then started. The oil is now added slowly, and the materials are emulsified by being run through the pump under pressure. After a few minutes the rest of the water may be added, and the spray is ready to be applied.

Certain "tree" distillates, testing 31° to 32° Baumé, said to be selected and partially refined, have lately displaced to a considerable extent the heavier distillates of 27° to 28° for use on citrus trees.

"Tree" Distillate Emulsion.

FORMULA 20

Tree distillate (31°-32° Baumé)	4 gallons
Liquid soap	$\frac{3}{4}$ gallon
(Or hard soap	4 to 12 pounds)
Water to make	200 gallons

These materials are emulsified in the manner explained for the kerosene emulsion, Formula 19. If the distillate is used without soap, the following is the formula:

Straight "Tree" Distillate.

FORMULA 21

Tree distillate (31°–32° Baumé)	4 to 6 gallons
Caustic soda (95 per cent)	7 pounds
Water to make	200 gallons

In the case of the straight distillate, the oil is kept in suspension in the water by agitation and forms an unstable mechanical emulsion, which separates quickly on standing. In using this it is necessary to have the spray outfit equipped with a powerful and efficient agitator, which must be kept going continuously during the spraying operation.

The use of petroleum-distillate sprays against black scale on olive trees is now being recognized as profitable. For this purpose the heavier distillates of 28° to 30° Baumé, being more effective, are used, since olive foliage is very resistant to spray injury, and also because the spray can be applied through the winter months when low temperatures and high humidities are the rule.

Distillates of this density are also much used as a dormant spray on deciduous trees, although crude oil sprays are replacing distillates more and more for this purpose.

Heavy Distillate Emulsions.—For use on olives, the following mechanical emulsion is recommended:

FORMULA 22

Distillate (28° Baumé)	7 gallons
Caustic soda (95 per cent)	5 to 7 pounds
Water to make	200 gallons

First dissolve the caustic soda in a small amount of water and add to the water in the spray tank; begin the agitation and slowly add the distillate, continuing the agitation during application. This spray will also remove lichens or moss from trees.

If the amount of crude oil is reduced from 25 gallons to 15 gallons in Formula 18, the crude oil emulsion may be used on olive trees for the control of black scale.

For use on dormant deciduous trees the following is recommended:

FORMULA 23

Distillate 27°–28° Baumé)	20 gallons
Fish oil soap	30 pounds
Water to make	12 gallons

Dissolve the fish oil soap in water, heating it to the boiling point; add the distillate, and agitate thoroughly while the solution is hot. For use, add 20 gallons of water to each gallon of the above mixture.

Commercial Prepared Emulsions and Miscible Oils.—Many growers realize the difficulty in securing proper materials for home-made emulsions and the variability of the home-made mixtures even under the best conditions. They prefer to buy manufactured products, especially when only small quantities are needed; but the commercial emulsions and miscible oils are no more effective than a good home-made preparation and are only more convenient. These preparations are on the market in great variety, many being sold under trade names. Practically all grades of petroleum distillates, as well as crude petroleum, are obtainable in a form ready to be used, after simple dilution with water. If these ready-made preparations are to be used, it is especially important to purchase only from reliable and well-known manufacturers or dealers. The commercial products in general are satisfactory for use for the purposes indicated for the above formulas.

The following is recommended for the control of thrips:

Distillate Emulsion and Tobacco Extract.—Government formula.

FORMULA 24

The government formula for the control of pear thrips is the following:

Distillate emulsion	10 gallons
Nicotine sulfate 40 per cent	1 pint
Water to make	200 gallons

When this formula was first prepared there were few commercial oil sprays on the market, so that it was necessary first to make a distillate emulsion (Formula 23). In recent years there have appeared the miscible oils, which may be used as follows:

FORMULA 24a

Miscible oil	5 gallons
Nicotine sulfate 40 per cent	1 pint
Water to make	200 gallons

These formulas are for use against the adult "black thrips," and should be applied liberally as soon as any considerable number of insects are found upon the trees. *Do not fail to make daily inspections after the buds begin to swell.* Applications should be repeated if necessary until the adults begin to lessen in numbers.

In case the "white thrips" appear in destructive numbers later, the same formula may be safely used if the oil content is decreased and the nicotine increased as follows:

FORMULA 24b

Distillate emulsion	6 gallons
Nicotine sulfate 40 per cent	1½ pints
Water to make	200 gallons

FORMULA 24c

Miscible oil	3 gallons
Nicotine sulfate 40 per cent	1½ pints
Water to make	200 gallons

For work with thrips, the greater force and volume delivery of the spray gun has rendered it superior to the spray rod, insuring not only a better but a quicker and easier job. The loss in material is more than overcome by the rapidity and ease of operation.

The resin wash is chiefly used for young and tender nursery stock, because it does not cause the injury often following the application of petroleum distillates. The preparation is:

FORMULA 25

Resin	10 pounds
Caustic soda (76 per cent to 95 per cent)	3 pounds
Fish oil	1½ pounds
Water to make	50 gallons

To a gallon of hot water in an iron kettle add the fish oil and the resin, and heat until the latter is softened. After first dissolving the caustic soda in a small quantity of water add it and stir the mixture thoroughly. After this pour in enough water to make 50 gallons of spray material.

Crude Carbolic Acid Emulsion.—For citrus trees.

FORMULA 26

Fish oil soap	40 pounds
Crude carbolic acid	5 gallons
Water to make	40 gallons

Dissolve the soap completely in hot water, add the carbolic acid and heat to the boiling point for twenty minutes (reserve some water to add in case the mixture begins to boil over.) For use, add 20 gallons of water to every gallon of the above solution. The emulsion needs little or no agitation.

CRUDE CARBOLIC ACID AND DISTILLATE EMULSION**FORMULA 26a**

Fish oil soap (or liquid soap, 5 gallons)	40 pounds
Crude carbolie acid (25 per cent)	5 gallons
Distillate 27°–28° Baumé)	5 gallons
Water to make	50 gallons

Prepare as with Formula 26, adding the distillate after the crude carbolie acid. This mixture is specially recommended for mealybugs on dormant deciduous fruit trees. Dilute 1 to 20 for use.

FORMULA 26b

Coal Tar Creosote Dip.—Coal tar derivatives which may be creosote oil, crude carbolie acid or cresylic acid emulsified by means of soap are also used. These are sold under various trade names and should be used according to directions. The requirement which has been made for such dips by the United States Department of Agriculture is that when diluted for use they shall contain “one per cent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of one per cent nor less than one-tenth of one per cent of cresylic acid.”

These preparations cannot be used in very hard water except by a preliminary water softening. Hard water may be softened by dissolving lye at the rate of 12 ounces of high-grade concentrated lye to 100 gallons of water; then add the dip.

If the emulsion still breaks or forms in globules after treatment with lye it will be necessary to use lime-sulfur solution or an arsenical dip.

TOBACCO PREPARATIONS

Concentrated commercial preparations of tobacco have almost entirely superseded the home-made tobacco infusions on account of their greater convenience and uniformity. A material containing 40 per cent nicotine in the form of nicotine sulfate is recommended for the preparation of contact insecticides containing nicotine. The usual formula is:

FORMULA 27

Tobacco extract (nicotine sulfate, 40 per cent)	1 pint
Fish oil soap	4 to 5 pounds
Water	100 to 150 gallons

For small quantities, use 1 teaspoonful to 1 gallon of water.

FORMULA 27a

Nicotine sulfate, 40 per cent	1 pint
Dry billboard paste	2 pounds
Water	150 gallons

Make a paste of the dry material and add it to the water and nicotine. This spray is intended for plants like potatoes, tomatoes, etc., which are sensitive to soap mixtures.

Tobacco Dust.—Finely ground tobacco dust finds some use as an insecticide, particularly in the control of aphids. Fifty per cent of kaolin or hydrated lime is sometimes mixed with it as a diluent.

NICODUST AND COMBINATIONS

Nicodust, invented and named by Professor Ralph E. Smith, is composed of a carrying substance, like finely powdered kaolin or lime, treated with a concentrated solution of nicotine sulfate, commercially known as "Nicotine Sulfate 40 per cent." The nicotine in such combination, especially with lime, becomes very volatile and is quickly driven off by heat. In this form therefore it acts largely as a fumigant, but may be effective as a contact poison as well. As soon as mixed, the dust should be packed in air-tight containers to retain the nicotine content. The best results in killing insects have been secured when the temperature is over 70° F., and very poor results have followed its use in cold weather. The various strengths are usually denoted by the amount of "Nicotine Sulfate 40 per cent" contained, as follows: 2 per cent "Nicotine Sulfate 40 per cent," 4 per cent, 5 per cent, 6 per cent, 10 per cent, etc. A statement of the actual amount of nicotine is more accurate and is required in the guarantee of commercial preparations.

The name nicodust does not belong exclusively to any particular mixture or company, but was originated as a convenient name for all mixtures of this sort.

Arsenate of lead and sulfur are mixed with nicodust at the time of manufacture and give convenient combinations for treating different types of insects or insects and fungus diseases at one application. Sulfur-nicodust, under actual field tests, appears to be more efficient in killing insects than ordinary nicodust containing the same percentage of "Nicotine Sulfate 40 per cent." Thus in the control of the rosy apple aphid, a sulfur-nicodust containing 50 per cent of sulfur, 6 per cent of "Nicotine Sulfate 40 per cent," and 44 per cent of inert material gave far better results than a 6 per cent nicodust.

The strengths commonly used are 2 per cent nicodust for walnut aphid and cherry or pear slug, 5 or 6 per cent for most of the aphids, thrips, etc., and a 10 per cent dust for the more resistant aphids such as the pea aphid. Nearly all of the hairy caterpillars, such as the tent caterpillars, webworms, thistle butterfly larvae, as well as the velvety cabbage worms, to which the nicodust adheres readily, are easily killed with a 6 per cent dust if applied while the caterpillars are quite young. Smooth caterpillars, like cutworms, on the other hand, do not readily succumb to any ordinary treatment with the material. Insects which are protected with a waxy or cottony material, like the woolly apple aphid, the mealy plum louse, mealybugs, etc., are not susceptible to nicodust at all, while those which have a wet or slimy covering, like the cherry or pear slug, or glandular hairs, like the walnut aphid, are easily killed with very weak nicotine contents.

Recently, machines for mixing and applying the materials at the same time have been devised. These promise increased efficiency and economy in some large-scale operations. (See University of California Bulletin No. 357.)

Hydrocyanic Acid Gas.—The most effective fumigant in common use, but on account of its danger to the operator should if possible be used only under expert supervision. The gas is lighter than air, diffusing upward very rapidly, hence the danger to occupant of upper or adjoining rooms. The danger of explosion and fire from the use of carbon bisulfid is practically eliminated with this gas.

Vacuum fumigation with this and other gases where possible is more successful than that in improvised fumigating rooms.

The gas is generated by adding the cyanid to a solution of sulfuric acid.

The amount of sodium cyanid required for a tightly built room is $1\frac{1}{2}$ ounces per 100 cubic feet, the chemicals being used in the following proportions:

Sodium cyanid	$1\frac{1}{2}$ pounds
Sulfuric acid	$2\frac{1}{4}$ pints
Water	3 pints

A room, 10 x 16 x 10 feet, contains 1600 cubic feet and would require $1\frac{1}{2}$ pounds of sodium cyanid, $2\frac{1}{4}$ pints (66 ounces by weight) of sulfuric acid, and 3 pints of water. The proportions for the chemicals given should not vary, but the amount used per hundred cubic feet must be determined according to the tightness of the room. The above amount of cyanid may be reduced one-third in a room built especially for fumigating purposes, with a corresponding change in

the amounts of acid and water. Twice the above dosage, or even more, should be used for buildings of only approximate tightness.

Liquid hydrocyanic acid gas is now used for citrus orchard fumigation. For full directions consult the local county agent or horticultural officers.

MISCELLANEOUS

Carbon Tetrachloride.—This may be substituted for carbon disulfid in household fumigation by using it in the same manner and slightly increasing the amount used. It is non-inflammable and consequently safer than carbon disulfid, while its lower toxicity makes it safer for the operator.

Corrosive Sublimate (Bichlorid of Mercury or Mercuric Chlorid).—This is a very poisonous substance and is one of the most powerful of germicides; it is employed to some extent in plant disease treatment. The usual strength is:

FORMULA 28

Corrosive sublimate	1 ounce
Water	8 gallons

Or 1 part to 1000.

Tablets to make this strength when added to 1 pint of water may be obtained at drug stores. Distilled or rain water should be used; the solution must not be kept in a metal container. It is also quickly spoiled by contact with clay or an organic substance such as the cut surfaces of potatoes.

Another formula is recommended by Mr. C. F. Reimer for disinfecting tools and cuts in pear blight control work. It will probably be found superior to Formula 28 for general tree work of this kind. It is:

FORMULA 28a

Corrosive sublimate	1 ounce
Mercuric cyanid	1 ounce
Water	4 gallons

Or 1 part of each ingredient to 500.

Whitewash.

FORMULA 29 (Ordinary Formula)

Water	2 gallons
Quicklime	10 pounds

Add more water after slaking to bring the wash to the desired consistency.

A more durable whitewash:

FORMULA 30

Quicklime	5 pounds
Salt	$\frac{1}{2}$ pound
Sulfur	$\frac{1}{4}$ pound

Slake the lime slowly with water and add the salt and sulfur while it is boiling. Add enough more water to make a good wash. This is good for whitewashing the bodies of trees in the fall. In localities where there are deer this whitewash is not recommended, as the deer are said to be attracted by the salt it contains and injure the trees.

Government Whitewash.

FORMULA 31

Quicklime	40 pounds
Salt	15 pounds
Rice flour	3 pounds
Spanish whiting	$\frac{1}{2}$ pound
Glue	1 pound
Water	5 gallons

Grafting Wax.—Many different combinations are used for this purpose, most of them being various combinations of beeswax and resin. The following formula is a good one:

FORMULA 32

Resin	4 pounds
Beeswax	1 pound
Linseed oil	1 pint

The ingredients are all melted and mixed together in a kettle. In hot weather use more resin.

Some use one pound of tallow as a substitute for the linseed oil. One ounce of lampblack or one pint of flour is sometimes added. Asphaltum is used to some extent as a substitute for resin and beeswax, and, in fact, straight asphaltum is used successfully in some cases for grafting wax.

Carbon Disulfid.—A liquid which evaporates quickly when exposed to the air, forming a heavy and inflammable vapor of great penetrating power. In using the material for fumigation, it is essential that it be placed near the top of the chamber in a shallow container in order that the heavy vapors as they are given off may thoroughly diffuse through the air contained in the space to be fumigated. The proper amount to use depends upon the type of room being fumigated and ranges from 10 pounds to about 30 pounds to 1000 cubic feet in

ordinary rooms where the walls and floor have not been made especially tight. The best results are obtained by doing this work when the temperature is above 70° F.

Carbon disulfid is one of the best agents for destroying ground squirrels that have failed to take poisoned grain, or having once survived the poison refuse to take it again. It is most effective if used during the winter season when the ground is wet. The best methods of applying it are by the use of the "waste-ball" and of the "destructor pump." The common waste-ball method is to pour a tablespoonful of carbon disulfid on a piece of cotton waste, corncob, horse manure, or other absorptive material, and then to throw this as far down the hole as possible, closing the opening immediately with earth. Exploding the gas with a torch before closing the opening is recommended where the ground is damp and there is no danger of fire. The explosion of gas forms new compounds which are poisonous and may diffuse somewhat more rapidly than the vapors of the material. The "destructor" pumps the vaporized carbon bisulfid into the burrow, and is said to be as effective as exploding the gas.

Poisoned Barley or Strychnine-coated Barley.—Following is the latest government formula for preparing poisoned barley for California ground squirrels.

FORMULA 33

Barley (clean grain)	16 quarts
Strychnine (powdered alkaloid)	1 ounce
Bicarbonate of soda (baking soda)	1 ounce
Thin starch paste	$\frac{3}{4}$ pint
Heavy corn syrup	$\frac{1}{4}$ pint
Glycerin	1 tablespoonful
Saccharin	$\frac{1}{10}$ ounce

Mix thoroughly 1 ounce of powdered strychnine (alkaloid) and 1 ounce of common baking soda. Sift this into $\frac{3}{4}$ pint of thin, hot starch paste and stir to a smooth, creamy mass. (The starch paste is made by dissolving 1 heaping tablespoonful of dry gloss starch in a little cold water, which is then added to $\frac{3}{4}$ pint of boiling water; boil and stir constantly until a clear, thin paste is formed.) Add $\frac{1}{4}$ pint of heavy corn syrup and 1 tablespoonful of glycerin and stir thoroughly. Add $\frac{1}{10}$ ounce of saccharine and stir thoroughly. Pour this mixture over 16 quarts of clean barley and mix well so that each grain is coated.

Caution.—All containers of poison and all utensils used in the preparation of poisons should be kept **PLAINLY LABELED** and **OUT OF REACH** of children, irresponsible persons, and live stock.

FORMULA 34

Poisoned Vegetables for Gophers

Sweet potatoes, parsnips, or carrots (cut in $\frac{3}{4}$ " cubes).....	4 quarts
Flour paste	$\frac{1}{4}$ pint
Strychnine alkaloid, powdered	$\frac{1}{8}$ ounce
Saccharin	$\frac{1}{32}$ ounce

SPREADERS

Spreaders are often added to sprays to give them a more even distribution over the surface of the leaves and to prevent them from collecting into drops. Some of them also have insecticidal value and others act as adhesives. So much is claimed for these materials which is not fully warranted that many persons have come to feel that none should be recommended. However, the advantages gained should not be entirely overlooked, and we include here some of the more important substances used for these purposes.

Casein.—This is a comparatively new material for use as a spreader and adhesive in sprays. It is a dry product which readily mixes in cold water and is put up in small or large containers. One and one-half pounds are sufficient for 200 gallons of the diluted spray. Casein is soluble only in alkaline solutions and is therefore worthless in acid insecticides and fungicides which are, however, seldom used.

Flour Paste, Billboard Paste.—These materials are excellent spreaders and act as adhesives as well. They may be used with safety in all sprays, because they give no chemical reactions. Flour paste and certain of the dry billboard and paperhanger's pastes should be mixed in a small quantity of hot water before adding to the spray tank. They are somewhat difficult to handle. A specially prepared billboard and paperhanger's paste, known as "steamed paste," is already cooked, and as a wet paste mixes readily with cold water. It may be obtained in barrel lots or in small quantities from paint and paper dealers. The amounts to be used are as follows:

Flour (cheap grade), 2 to 4 pounds to 200 gallons of dilute spray material.

Dry billboard paste, 2 pounds to 200 gallons of dilute spray material.

Steamed paste, 4 pounds to 200 gallons of dilute spray material.

Glue.—As a spreader and adhesive, glue has long been used in sprays, and, like the flour pastes, may be used in all kinds of materials. Two ounces of dry glue dissolved in hot water are sufficient for 200 gallons of diluted sprays.

Oil Emulsions and Miscible Oils.—Because of their penetration, these materials are often of value in carrying other materials, like nicotine. They should be used sparingly, about 2 gallons to 200 gallons of diluted spraying materials. When so diluted they have little value except as spreaders.

Resin-fish oil soap (see Formula 10a) is often used with Bordeaux mixture. It is somewhat tedious to prepare and may now be purchased ready to use. This is very similar in character to the resin wash (see Formula 25).

Soap.—This is one of the oldest and best known spreaders and is often used in sprays for this purpose as well as for an emulsifier and insecticide. As a spreader for such materials as arsenate of lead, for codling moth, use 4 to 12 pounds of fish oil soap to 200 gallons of diluted spray material.

HEAT AS AN INSECTICIDE

A temperature of 130° F., as far as records go, if prolonged for several hours, will kill all forms of insect life. This temperature can readily be obtained in well-built buildings which are connected with a steam plant. The first expense of installing radiators is considerably more than fumigation with chemicals, but after-treatments are very much cheaper and without danger to the operators or to the contents of the building.

Higher temperatures of 145° to 180° F. have been reported as successful in a much shorter period of time than the first figure mentioned. The desired degree of heat, however, must be obtained throughout the entire mass which is being treated, it not being sufficient to heat the room alone to 145° or more. Small amount of provisions or woolen cloths infested with moths may be heated for thirty or forty minutes, in the oven of an ordinary cook stove, care being taken to avoid scorching heat. A temperature high enough to slightly brown a white paper bag will be found about right. The use of a smoothing iron just hot enough not to scorch will kill the larvae of clothes moths while in the cloth, but other measures must be taken to reach the adult insects.

SOIL DISINFECTION

For the prevention of damping off and of many specific soil-borne infections, treatment may be practical in cases such as seedbeds, greenhouse soil or where limited amounts of material are to be dealt with. Plants at first are slightly retarded, but soon grow with increased vigor in properly disinfected soils.

Steam Cooking is generally considered the most effective method of soil treatment for the above purposes and various devices have been employed for doing the work. A system of 1½ inch pipes may be laid 18 inches apart and 1 foot below the surface. These pipes should be perforated on their lower sides with ¼-inch holes at intervals of 6 inches and should be supplied with steam at a pressure of 80 to 150 pounds pressure. The soil should be covered with blankets before the steam is admitted, and potatoes buried in different places in the soil. After treatment for an hour, the potatoes may be examined and if cooked, the treatment may be considered effective. The soil may be used in place or may be removed to clean benches or beds, using care not to again contaminate it. Benches, frames, etc. should be drenched with boiling water or formaldehyde solution before use. See below.

The Inverted-Pan Method consists in admitting steam below an inverted galvanized iron pan, furnished with handles for moving, and which is pressed down to confine the steam. A size of 6' x 8', and 6 inches deep has been recommended. Injurious insects, fungi, nematodes and weed seed are destroyed by steam cooking and it has been reported in some cases that the cost has not been greater than that of weeding untreated soil.

Surface Firing.—Brush is frequently piled on seedbeds prepared for sowing and burned. Seed is sown as soon as possible with a minimum stirring of the surface. The effect in this case is very superficial.

Formaldehyde Treatment.—Formaldehyde may be used on seedbeds prepared to sow. The soil may be soaked with a solution of 1 pound of formalin in 6 gallons of water. The soil should be kept covered for a day and allowed to stand for a week before sowing.

Hot Water Treatment.—Considerable benefit may be derived from drenching the soil with boiling water. Empty pots, flats, pots with soil, and implements may be immersed in boiling water for five minutes.

WEED KILLERS, TREE KILLERS

Salt.—Common salt may be applied on walks or similar places where it is desired to prevent the growth of all vegetation. In the studies of barberry eradication it was found that 10 pounds of common salt poured about the base of the large shrubs was one of the surest means of eradication. Soil with which the salt comes in contact is injured for growing plants.

Sodium Arsenite.—See p. 73. This is one of the most widely used of weed killers. Sprayed on foliage or the soil it is very destructive to vegetation. Like common salt, it permanently injures soil where applied in considerable quantity. 1 pound of the arsenic in 10 to 25 gallons of water may be sprayed on soil or foliage. For killing trees, use 1 pound to 2 gallons of water, girdle the tree by downward strokes of the axe and pour about 1 pint to 1 quart of the solution into the cuts. This is a dangerous poison whether to handle, to get on fodder, or to inhale its fumes when preparing it.

Carbon Disulfid.—For killing morning glory, apply in dry soil in holes 18 inches deep and 3 feet apart each way. Put 4 ounces of the liquid in each hole and cover. This does not permanently injure the soil. See also under "Lawns," p. 31.

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